



Approved for Distribution
/s/ Beverly R. Cameron

MEMORANDUM

TO: Beverly R. Cameron, City Manager
FROM: Doug Fawcett, Director of Public Works
DATE: July 6, 2011
SUBJECT: Regional Water Supply Plan

ISSUE

Conduct a public hearing on the proposed regional water supply plan and subsequent adoption of the plan.

RECOMMENDATION

A required public hearing on the proposed plan has been advertised to be held at the July 12 City Council meeting. We recommend that Council conduct the hearing at that meeting and then schedule action on the plan at its August 23 meeting.

DISCUSSION

As a result of many Virginia communities experiencing difficulties during the 2002 drought, the Commonwealth of Virginia initiated a state-wide water supply planning process. In November, 2005, the State Water Control Board adopted regulations requiring localities to prepare water supply plans. Localities must submit their plans to the Commonwealth by November, 2011 for incorporation into the state-wide plan. Localities must then review and update their plans every five years.

Spotsylvania County, with the assistance of a consultant and with review and input by City staff, has prepared a regional water supply plan for the County and the City. The plan contains extensive water supply information, including current and future raw water supply sources (e.g., the Rappahannock River, reservoirs, ground water, etc.) as well as population projections and associated water demand projections for both localities. A copy of the proposed plan is attached. A copy has been placed at the Central Rappahannock Regional Library Headquarters for public review and the document has also been posted on the City's website.

The Spotsylvania County Board of Supervisors conducted a public hearing on the plan (one speaker, whose comments related to the issue of establishing Urban Development Areas) and adopted the plan at its June 28 meeting.

FISCAL IMPACT

The City's share of the cost of the preparation of the plan is \$50,000. The plan does not obligate the City to perform any specific capital improvements or to otherwise expend funds to implement the plan.

Attachment: Regional Water Supply Plan (April 2011)



Spotsylvania County, VA and City of Fredericksburg

REGIONAL WATER SUPPLY PLAN

April 2011



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TABLE OF CONTENTS

1.0	INTRODUCTION AND PURPOSE	1-1
1.1	Background	1-1
1.2	Planning Area	1-2
1.3	Purpose and Summary.....	1-2
2.0	EXISTING WATER SOURCES (9 VAC 25-780-70).....	2-1
2.1	Community Water Systems Using Groundwater.....	2-2
2.2	Community Water Systems Using Surface Water Reservoirs and Stream Intakes.....	2-4
2.3	Self-supplied Users using Groundwater	2-11
2.4	Self-supplied Users using Surface Water	2-13
2.5	Self-supplied Users on Individual Wells.....	2-13
2.6	Agricultural Users.....	2-15
3.0	EXISTING WATER USE INFORMATION (9 VAC 25-780-80)	3-1
3.1	Community Water Systems	3-1
3.2	Self-supplied Users.....	3-1
3.3	Total Water Use	3-3
4.0	EXISTING RESOURCE CONDITIONS (9 VAC 25-780-90)	4-5
4.1	Geologic Conditions	4-5
4.2	Hydrologic Conditions.....	4-6
4.3	Watersheds	4-8
4.4	Natural Heritage Resources	4-10
4.5	Sites of Historic or Archaeological Significance	4-11
4.6	Unusual Geologic Formations or Special Soil Types	4-13
4.7	Flood Plains	4-15
4.8	River Segments that have Recreational Significance, Including State Scenic River Status	4-16
4.9	Wetlands	4-18
4.10	Riparian Buffers and Conservation Easements.....	4-19
4.11	Land Use.....	4-21
4.12	The Presence of Impaired Streams and the Type of Impairment	4-23

4.13	The Location of Point Source Discharges.....	4-26
4.14	Potential Threats to the Existing Water Quantity and Quality.....	4-26
5.0	PROJECTED WATER DEMAND	5-1
5.1	Historical and Future Population Growth.....	5-1
5.2	Projected Water Demand	5-4
6.0	WATER DEMAND MANAGEMENT (9 VAC 25-780-110)	6-1
6.1	Water Use Efficiency Measures	6-2
6.2	Water Use Reduction Measures	6-3
6.3	Water Loss Reduction Measures	6-4
7.0	DROUGHT RESPONSE AND CONTINGENCY PLANS (9 VAC 25-780-120)	7-1
7.1	Purpose	7-2
7.2	Existing Drought and Contingency Plans	7-2
8.0	STATEMENT OF NEED AND ALTERNATIVE ANALYSIS	8-1
8.1	Statement of Need.....	8-1
8.2	Alternative Analysis	8-2
8.3	Conceptual Development of Alternatives	8-3
8.4	Preliminary Alternatives Evaluation	8-21
8.5	Preliminary Alternatives Screening / Workshop Results	8-22
8.6	Secondary Alternatives Evaluation	8-26
8.7	Alternative Analysis Conclusions	8-30

LIST OF TABLES

Table 2-1:	Community Water Systems on Groundwater	2-4
Table 2-2:	Spotsylvania County Surface Water Supplies	2-6
Table 2-3:	Self-supplied Users on Groundwater.....	2-12
Table 2-4:	Self-supplied Users on Surface Water	2-13
Table 2-5:	VDH list of Small Self-supplied Users.....	2-13
Table 3-1:	Summary of Community Water System Withdrawals for Use	3-3
Table 3-2:	Summary of Spotsylvania County Withdrawals.....	3-4
Table 3-3:	Summary of Monthly CWS Withdrawals for Use.....	3-5
Table 3-4:	2009 CWS Disaggregated Use.....	3-10
Table 3-5:	Summary of Self-Supplied User Withdrawals (Non-Ag)	3-2
Table 3-6:	Summary of Self-Supplied Agricultural Withdrawals	3-3
Table 3-7:	Estimated Total Water Use	3-4
Table 4-1:	Climate Summary.....	4-7
Table 4-2:	Flow Statistics (USGS Water Data Report 2009).....	4-10
Table 4-3:	Impaired Waters	4-25
Table 5-1:	Historical Population.....	5-1
Table 5-2:	Population Projections Breakdown	5-3
Table 5-3:	Public Community Water Demand Projection (MGD).....	5-4
Table 5-4:	Private Community Water Systems Demand Projection (MGD)	5-35
Table 5-5:	Self-Supplied, Non Agricultural Demand Projection (MGD).....	5-7
Table 5-6:	Self-Supplied Demand Projection (MGD)	5-9
Table 8-1:	Ranking of Preliminary Alternatives	8-23
Table 8-2:	Capital Cost and Potential Yield Summary	8-27
Table 8-3:	Portfolio of Recommended Alternatives	8-29

LIST OF FIGURES

Figure 1-1:	Regional Water Supply Planning Area	1-2
Figure 2-1:	Community Water Systems	2-2
Figure 2-2:	Spotsylvania County Surface Water Supplies Schematic	2-5
Figure 2-3:	Rapidan River Raw Water Intake & Pump Station Schematic	2-8
Figure 2-4:	Rappahannock River Raw Water Intake & Pump Station Schematic	2-10
Figure 2-5:	Self-supplied Users – Greater than 300,000 gallons per month	2-12
Figure 3-1:	Community Water System Monthly Water Use	3-6
Figure 3-2:	Spotsylvania County Monthly Water Withdrawals	3-7

Figure 3-3:	Disaggregated Water Use	3-8
Figure 4-1:	Geology	4-5
Figure 4-2:	Annual Average Precipitation	4-6
Figure 4-3:	Aquifers	4-8
Figure 4-4:	Watersheds	4-9
Figure 4-5:	Anadromous Fish Use	4-11
Figure 4-6:	Historical Sites	4-12
Figure 4-7:	Soil Types	4-13
Figure 4-8:	Flood Plains	4-16
Figure 4-9:	Scenic Rivers.....	4-17
Figure 4-10:	Wetlands	4-18
Figure 4-11:	Conservation and Resource Protection Areas	4-20
Figure 4-12:	Riparian Buffers (VA Department of Forestry, 2003)	4-21
Figure 4-13:	Land Cover	4-22
Figure 4-14:	Future Land Use	4-23
Figure 4-15:	Impaired Waterways and Point Source Discharges.....	4-24
Figure 5-1:	Spotsylvania County and City of Fredericksburg Population Projections.....	5-2
Figure 5-2:	Spotsylvania County Population Projection Breakdown	5-3
Figure 5-3:	Municipal Community Water System Demand Projections	5-5
Figure 5-4:	Spotsylvania County Water Disaggregated Water Use Projection.....	5-34
Figure 5-5:	City of Fredericksburg Water Disaggregated Water Use Projection	5-6
Figure 5-6:	Private Community Water Systems Demand Projection.....	5-7
Figure 5-7:	Self-Supplied Demand Projection	5-8
Figure 5-8:	Self-Supplied Demand Projection	5-9
Figure 8-1:	Source Capacity Adequacy Plot (average day demand projections)	8-1
Figure 8-2:	Alternative Analysis Process	8-3
Figure 8-3:	Spotsylvania County Watersheds	8-5
Figure 8-4:	Falls Quarry near I-95 and City of Fredericksburg	8-15
Figure 8-5:	Map of Alternatives (Circles represent general area of alternative).....	8-20
Figure 8-6:	Preliminary Alternative Analysis Criteria and Weighting	8-22
Figure 8-7:	Secondary Alternatives Comparison.....	8-29

LIST OF APPENDICES

APPENDIX A: Drought Ordinance

LIST OF ABBREVIATIONS

AA.....	Annual Average
ADF.....	Average Daily Flow (same as Annual Average flow)
CDP.....	Criterion Decision Plus©
CWS.....	Community Water System
ft.....	Feet
FW	Finished Water
GPD	Gallons per Day
gpm	Gallons per Minute
GW	Groundwater
MG/mg.....	Million Gallons
MGD/mgd	Million Gallons per Day
MSL.....	Mean Sea Level
PS.....	Pumping Station
PWSID.....	Public Water System Identification
RW	Raw Water
SW	Surface Water
TAC	Technical Advisory Committee
TRI	Toxic Release Inventory
USACE.....	US Army Corps of Engineers
VDEQ.....	Virginia Department of Environmental Quality
VDH	Virginia Department of Health
VPDES	Virginia Pollutant Discharge Elimination System
VWP.....	Virginia Water Protection (Permit)
WTP	Water Treatment Plant

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1.0 INTRODUCTION AND PURPOSE

Principally due to its ideal location, midway between the Washington, DC and Richmond metropolitan areas, and high quality lifestyle available, Spotsylvania County has experienced rapid population growth in the past decades, although growth has slowed in recent years. The City of Fredericksburg has experienced moderate population growth over this timeframe. Further population growth is projected for both the City and the County over the planning period, but at a more moderate rate. The County government has traditionally taken a proactive approach to planning for water resources, and in managing resources for long-term sustainability. The purpose of this planning effort is to develop a Regional Water Supply Plan for submittal to the Commonwealth of Virginia and inclusion in the State Water Supply Plan upon acceptance.

1.1 Background

As a result of many Virginia communities experiencing difficulties during the drought of 2002, the State convened the Water Policy Technical Advisory Committee (TAC). The goal of the TAC was to develop a water supply planning initiative to improve the Commonwealth's water resources planning activities to meet future water demands in an environmentally sound manner. The TAC was comprised of people representing conservation interests, agricultural, trade organizations, power generation, regional interests, local and regional managers, State and Federal agencies, academic interests, and recreation. The goals of the TAC were: (1) Develop a preliminary state water supply plan, and (2) Draft state regulatory criteria for local and regional plans. These goals were met and resulted in water supply planning regulations being adopted in autumn 2005.

The State Water Control Board adopted 9 VAC 25-780 "Local and Regional Water Supply Planning Regulations," effective November 2, 2005. These regulations require that each jurisdiction in the state prepare and submit to the State a local water supply plan to be included in the State Water Supply Plan upon approval.

The regulations required that local plans be submitted by November 2, 2008 for localities with populations greater than 35,000, by November 2, 2009 for those less than or equal to 35,000 but greater than 15,000, and by November 2, 2010 for those less than or equal to 15,000. Alternatively, local governments could elect to participate in a regional water supply planning

effort, such as this plan which includes Spotsylvania County and the City of Fredericksburg. Regional water supply plans must be submitted to the State by November 11, 2011.

1.2 Planning Area

This Regional Water Supply Plan includes the entirety of Spotsylvania County and the City of Fredericksburg. All water sources, community water systems, and self-supplied users within the County and the City are considered in this plan. Figure 1-1 shows the geographic extent of the planning area.

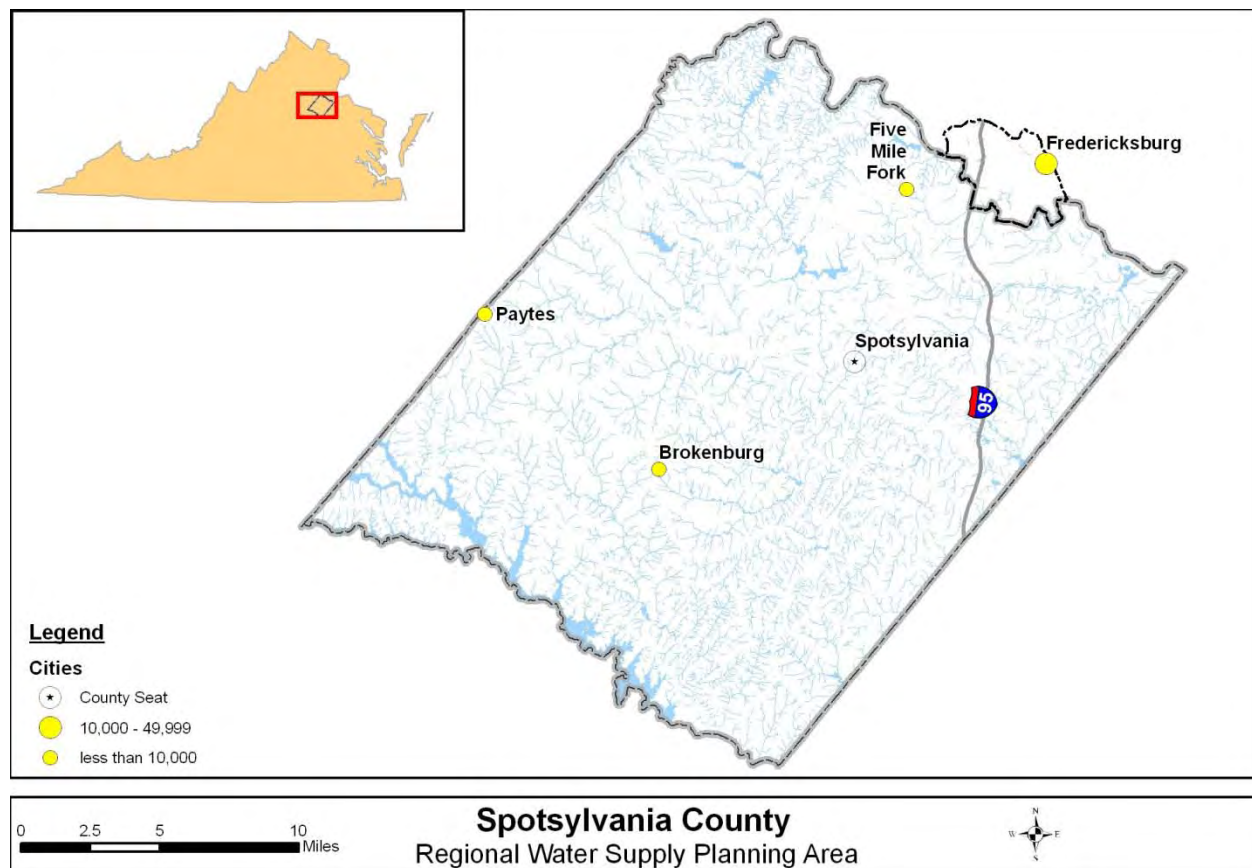


Figure 1-1: Regional Water Supply Planning Area

1.3 Purpose and Summary

This Regional Water Supply Plan complies with the State Water Control Board's regulation 9 VAC 25-780, Local and Regional Water Supply Planning.

The purpose of the regulation is to establish a comprehensive water supply planning process for the development of local, regional, and state water supply plans. This process is designed to:

- Ensure that adequate and safe drinking water is available to all citizens within the region;
- Encourage, promote, and protect all other beneficial uses of the region's water resources;
- Encourage, promote, and develop incentives for alternative water sources; and
- Promote conservation.

This plan summarized existing water sources, reviewed current water demands, and projected future water demands. As a result of an adequacy evaluation, this plan determined that the County has the source water capacity to meet the average demand projections through the year 2060. Based on the alternative analysis included in the plan, there are multiple viable options to address the source water capacity beyond 2060. Due to the lack of immediate need for additional source water, the most cost-effective alternatives were included in a portfolio of preferential alternatives. It should be noted that once this plan is approved, this plan will be reviewed every five years.

2.0 EXISTING WATER SOURCES (9 VAC 25-780-70)

This section contains information on existing water sources for community water systems and self-supplied users within the study area in accordance with the requirements of 9VAC 25-780-70.

A community water system is defined as “a waterworks that serves at least 15 service connections used by year-round residents or regularly serves at least 25 year-round residents, and is regulated by the Virginia Department of Health Waterworks Regulation (12 VAC 5-590).” A listing of community water systems (CWS) in Spotsylvania County and the City of Fredericksburg was obtained from the Virginia Department of Health (VDH) Listing of Waterworks and Owners¹. The list included several systems using both surface water and groundwater.

A self-supplied user is defined as “any person making a withdrawal of surface water or ground water from an original source for their own use”. Self-supplied users do not receive water from a community water system and do not necessarily withdrawal water for the purpose of providing drinking water. A listing of water users in Spotsylvania County and the City of Fredericksburg that use greater than 300,000 gallons per month was provided by the Virginia Department of Environmental Quality (DEQ) from their Environmental Data Water resources Development database (EDWrD), this list supplemented the information provided by VDH.

As shown in Figure 2-1, community water systems provide water for the more urbanized areas of the planning area, including the City, its suburbs, and the I-95 corridor. Most of this area is served by the County or the City, with small private systems servicing individual communities inside and outside of the public water systems service areas. The rest of the county is served by self-supplied users who own and operate private wells.

¹ Data obtained from http://www.vdh.state.va.us/DrinkingWater/waterworks_owners.htm, accessed July 15, 2010.

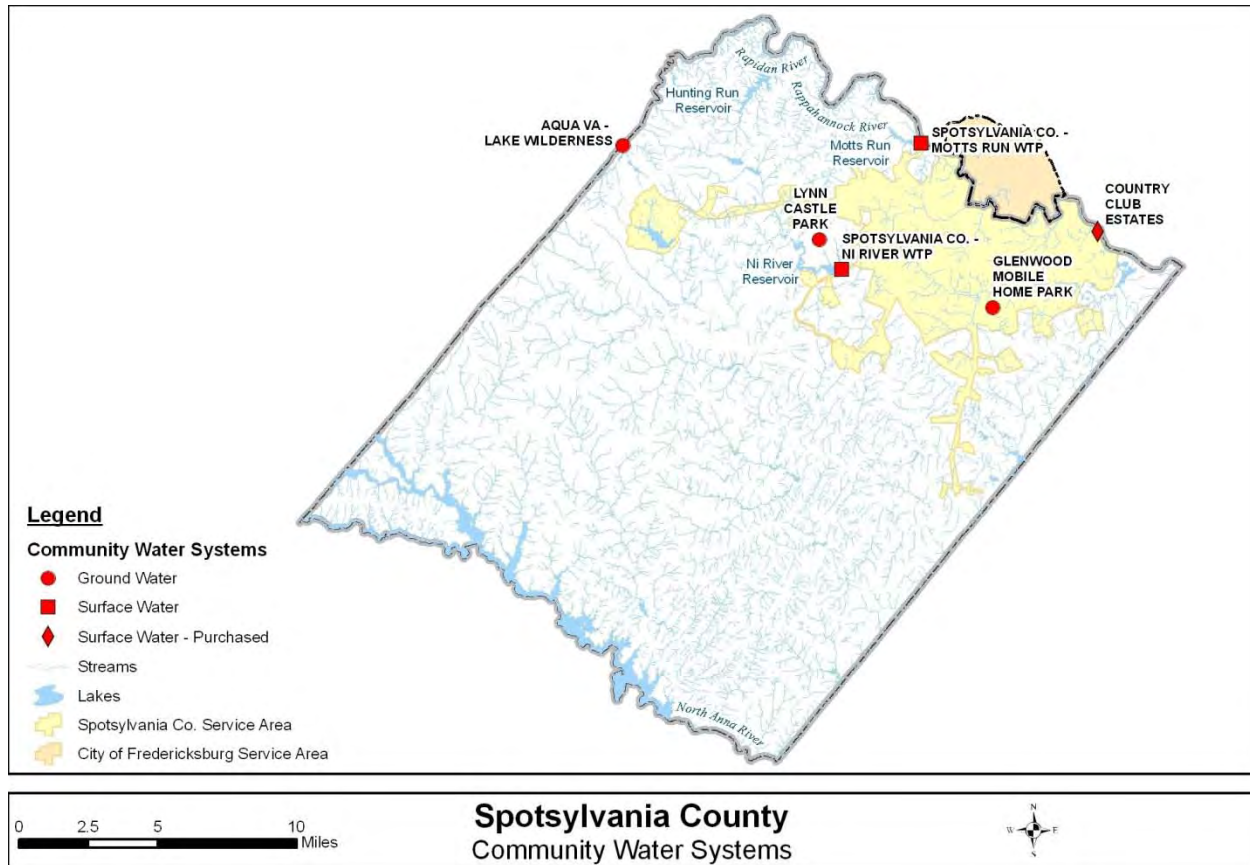


Figure 2-1: Community Water Systems

2.1 Community Water Systems Using Groundwater

There are currently four community water systems using groundwater as listed below and shown on Table 2-1.

- Glenwood Mobile Home Park (PWSID 6177105);
- Lake Wilderness, Sec 1-11 (PWSID 6177251);
- Lake Wilderness, Sec 12-16 (PWSID 6177252); and
- Lynn Castle Park (PWSID 6177266).

Each well system is described briefly below. Table 2-1 provides a summary of the system permitted and design capacities. There are also two community water system wells located within Spotsylvania County that are part of the Aqua Virginia - Lake Land'Or system. The end users of this system and the majority of its wells are located in Caroline County; therefore, the system is not accounted for in this plan.

Glenwood Mobile Home Park (PWSID 6177105) is a small private community water system located south of the City of Fredericksburg in the eastern portion of Spotsylvania County. The system consists of four wells and provides water to approximately 175 people via 75 connections. There is limited information on record regarding the design capacity of the four wells; however, the storage capacity is 3,334 gallons per day (gpd). The VDH permitted capacity of the system is 76 connections based on historical performance.

Lake Wilderness, Sec 1-11 (PWSID 6177251) and Lake Wilderness, Sec 12-16 (PWSID 6177252) comprise two small private community water systems owned and operated by Aqua Virginia. The systems are located along the northwestern boundary of Spotsylvania County near Lake Wilderness. The systems provide water to a total of 2,084 people (834 connections) through a system of eight wells.

Lake Wilderness, Sec 1-11 is comprised of five wells and has a permitted capacity of 0.26 million gallons per day (MGD), limited by the storage capacity available. The maximum daily design capacity of the system is 0.29 MGD, limited by either pumping capacity or well yield, depending upon the well. For several of the wells, there appears to be some opportunity to increase the capacity by increasing pumping capacity of Wells 1, 4 and 4a.

Lake Wilderness, Sec 12-16 is comprised of three wells and has a permitted capacity of 0.17 MGD, limited by calculated yield capacity, as defined by VDH. The maximum daily design capacity of the system is 0.23 MGD, limited by the pumping capacity for all wells. This suggests there may be some opportunity to increase the system capacity by increasing pumping capacity of Wells 6, 7 and 8.

Lynn Castle Park (PWSID 6177266) is a small private community water system located in Spotsylvania County. The system provides water to approximately 120 people (40 connections) through a single well. The system's permitted capacity is 40 connections, while the design capacity based on well yield is 0.04 MGD. The well is not metered.

Table 2-1: Community Water Systems on Groundwater				
System Name	No. of Wells	Permitted Capacity (MGD)	Design - Max Daily Withdrawal (MGD)	Potential Max Yield* (MGD)
Glenwood MHP	4	76 connections	UKN	UKN
Lake Wilderness, Sec. 1 - 11	5	0.26	0.29	0.52
Lake Wilderness, Sec.12 -18	3	0.17	0.17	0.30
Lynn Castle Park	1	40 connections	UKN	0.04

*Total system yield potential based on individual well pump tests if available.

2.2 Community Water Systems Using Surface Water Reservoirs and Stream Intakes

There are currently three community water systems using surface water in the study area. They include Spotsylvania County with two reservoir and water treatment plant systems and two wholesale customers that purchase water from Spotsylvania County, as listed below.

- Spotsylvania County's Ni River Reservoir and associated water treatment plant (PWSID 6177300);
- Spotsylvania County's Motts Run and Hunting Run Reservoirs (system of interconnected, pumped-storage reservoirs) and associated Motts Run Water Treatment Plant (PWSID 6177280);
- The City of Fredericksburg (PWSID 6630050), which purchases surface water from Spotsylvania County via a direct connection to the Motts Run Water Treatment Plant; and
- Country Club Estates (PWSID 6177050), a private system owned by Aqua Virginia, which purchases water from Spotsylvania County.

Spotsylvania County is the primary supplier of water in the planning area, serving the more developed areas of the County and the entirety of the City of Fredericksburg, as a consecutive system. In 2009, Spotsylvania County distributed water to 39,991 customers within the County and another 22,818 customers via wholesale to the City. The County supply originates from three

reservoirs, the Ni, Hunting Run and Motts Run Reservoirs and is treated at the Ni and Motts Run Water Treatment Plants, which have a combined permitted capacity of 21 MGD.

The Ni Reservoir is a conventional run of river reservoir that feeds the Ni River WTP. Hunting Run and Motts Run comprise a system of pumped storage reservoirs that feed the Motts Run WTP. The Hunting Run reservoir provides storage for flow augmentation of the Rappahannock River during periods of low flow via pumped storage from the Rapidan River. The Motts Run Reservoir and direct withdrawal from the Rappahannock River are the source water for the Motts Run WTP. The reservoir systems are described in the following paragraphs and are depicted schematically in Figure 2-2. Table 2-2 provides a summary of the system capacities.

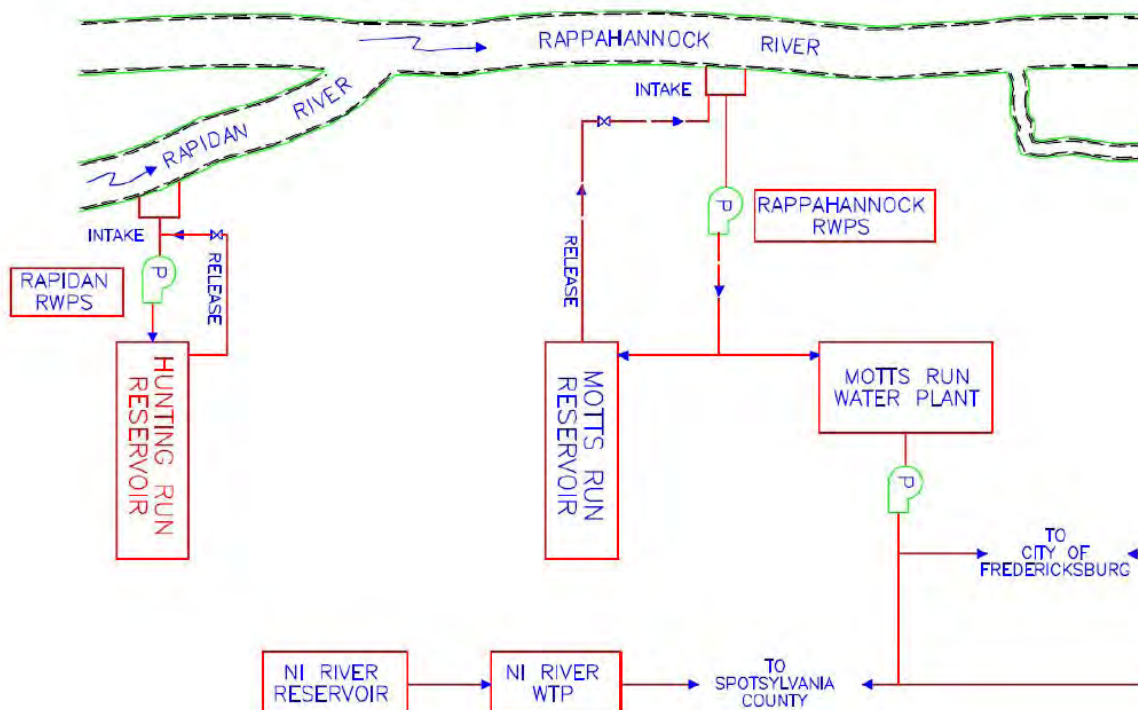


Figure 2-2: Spotsylvania County Surface Water Supplies Schematic

Table 2-2: Spotsylvania County Surface Water Supplies					
System Name	Safe Yield (MGD)	DEQ - Permitted Avg Daily Withdrawal (MGD)	DEQ – Permitted Max Daily Withdrawal (MGD)	VDH -WTP Permitted Capacity (MGD)	WTP Design Capacity (MGD)
Ni River Reservoir	4	4	NA	6.0	6.0
Rapidan River		NA	24		-
Hunting Run Reservoir	8	8	NA		-
Rappahannock River	6 (From Permit)	17.4	30	15	13
Motts Run Reservoir	3.4	3.4	NA		
Total	21.4			21	19.5

NA – not applicable

2.2.1 Spotsylvania County's Ni River Reservoir

The Ni Reservoir was constructed in 1974 by the U.S. Department of Agriculture, Soil and Conservation Service. This 417 acre reservoir has a drainage area of 24.5 square miles and is located on the Ni River in Spotsylvania County. The Ni Reservoir is the source for the Ni River Water Treatment Plant (PWSID 6177300). The total storage volume at the normal pool elevation of 237.5 ft above mean sea level (ft, MSL) is 1,426 million gallons (MG)². The volume of water used for water supply is set by the elevation of the lowest intake at 218 ft, MSL. The dead storage is considered the water volume below the lowest intake. The dead storage for this reservoir is 43 MG, resulting in a total usable storage volume for the Ni Reservoir of 1,383 MG.

According to the 2002 Water/Sewer Master Plan Revisions (HSMM, February 2002) the safe yield of the Ni Reservoir has been calculated a number of times. The Master Plan states the following:

“The safe yield, as defined by the Virginia Water Control Board, is 4.0 mgd annual average withdrawal. Safe yield was re-calculated in 1999 during the 1998-1999 drought

² According to a bathymetric survey conducted in April 2009 by Apex Companies LLP

at 4.3 mgd; however, the 1998-1999 drought was not confirmed to be the drought of record.”

An updated safe yield analysis was performed in 2009 by Black & Veatch to confirm the yield estimates from this previous study. This analysis confirmed that the previous studies were conservative, and that the Ni Reservoir safe yield is at least 4.0 mgd.

The Ni River WTP is permitted at 6 MGD, which is also the design capacity of the plant. However, the maximum production capacity is limited to 4.5 MGD.

2.2.2 Hunting Run Reservoir and Intake

Hunting Run Reservoir was constructed in 2002 along Hunting Run Creek which is a tributary to the Rapidan River. This 430 acre pumped storage reservoir is refilled by pumping water from the Rapidan River. The normal pool elevation of Hunting Run Reservoir is at 246 ft, MSL with a total storage volume of 2,913 MG. The minimum pool elevation is set by the lowest intake at 221 ft, MSL creating a dead storage volume of 688 MG. The total usable storage for the reservoir is calculated as 2,225 MG.

The Rapidan River intake facility consists of three screens and a 36-inch raw water conduit to the raw water pumping station. The raw water pumping station includes three 8 mgd vertical turbine pumps. Raw water is pumped from the Rapidan River to the Hunting Run Reservoir. Water from the reservoir water can then be released back through the intake facility and to the river for subsequent withdrawal from the Rappahannock River raw water intake facility at Motts Run. Figure 2-3 shows a schematic of the Rapidan River intake arrangements.

According to the 2002 Water/Sewer Master Plan Revisions (HSMM, February 2002), the safe yield for the Hunting Run Reservoir has been previously estimated as 8 mgd. Additionally, the VWP Permit No. 94-1134M (effective date April 20, 2009) states that 8.0 mgd derived from the Hunting Run Reservoir can be withdrawn from the Rappahannock River for subsequent pumping to the Motts Run WTP.

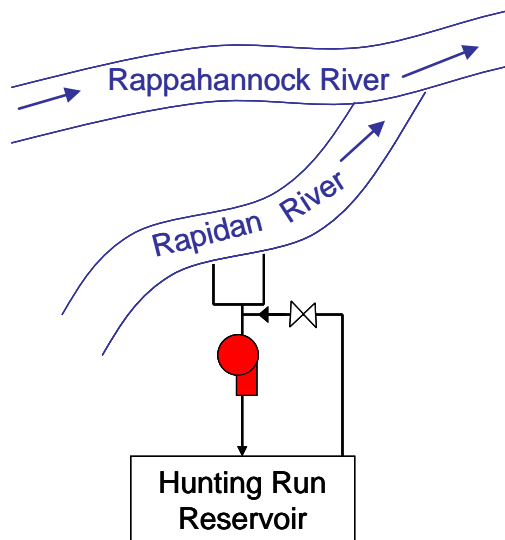


Figure 2-3: Rapidan River Raw Water Intake & Pump Station Schematic

2.2.3 Motts Run Reservoir and Rappahannock River Intake

Motts Run Reservoir was originally constructed in 1971 and upgraded in 2002. The intake on the Rappahannock River and the adjacent WTP were constructed in 2000. This pumped storage reservoir is jointly owned by the City of Fredericksburg and Spotsylvania County, and is operated by Spotsylvania County.

This 160 acre reservoir is located on Motts Run, a tributary to the Rappahannock River, in northern Spotsylvania County near the City of Fredericksburg. According to a bathymetric survey conducted in April 2009 by Apex Companies LLP, the total storage volume at the normal pool elevation of 150 ft, MSL is 1,203 MG. Minimum pool is set at 120 ft, MSL based on the lowest intake level, with an estimated dead storage volume of 310 MG. The usable volume for the reservoir is calculated as 893 MG. The data from the bathymetric survey did not go below elevation 130 ft, MSL, and therefore, an updated estimate of dead storage was not available. Therefore, the estimate of 310 MG was taken from previous studies.

The safe yield of the Motts Run Reservoir was estimated by Gannett Fleming in 1996 as 3.4 mgd. Additionally, the Virginia Water Protection (VWP) Permit No. 94-1134M (effective date March 21, 1995; expiration date March 21, 2005) states that 3.4 mgd derived from the Rappahannock River can be withdrawn from the Motts Run Reservoir. An updated safe yield analysis was performed by Black & Veatch in 2009 to confirm the yield estimates from the

previous study. This analysis confirmed that the previous studies were conservative, and that the Motts Run Reservoir safe yield is at least 3.4 MGD.

The Motts Run Reservoir is refilled via both inflow from Motts Run and a raw water pump station on the Rappahannock River. The Rappahannock River Intake is located along the south bank of the Rappahannock River. This screened intake withdraws water from the Rappahannock River to supply the Motts Run WTP and to replenish storage in the Motts Run Reservoir. The Rappahannock River Intake comprises four major components: four (one for future) 48-inch diameter intake screen assemblies, a Duplex Airburst system with control panel, a compressed air deicing system and a raw water intake flushing system. The Rappahannock River Intake has a design capacity of 34 MGD, with 24 MGD to the WTP and 10 MGD to the Motts Run Reservoir.

The multi-purpose pump station delivers river water to the reservoir for storage or to the water treatment plant directly. These same pumps can also be used to deliver raw water from Motts Run Reservoir to the water treatment plant. Finally, reservoir water can be released to the river to flush the intake sump. A schematic of the Rappahannock River intake and pumping system is presented in Figure 2-4.

The Rappahannock River Raw Water Pump Station is equipped with five vertical turbine pumps (with room for another in the future). Three of the existing pumps have the capability to pump river water to the reservoir or WTP and also to pump reservoir water to the WTP. The other two pumps can either pump river water to the reservoir or reservoir water to the WTP. The total capacity for pumping from the river to the reservoir or WTP at any given moment is 47.2 MGD, with a firm capacity of 35.2 MGD. The Motts Run WTP is permitted at 15 MGD and design capacity of 13 – 13.5 MGD.

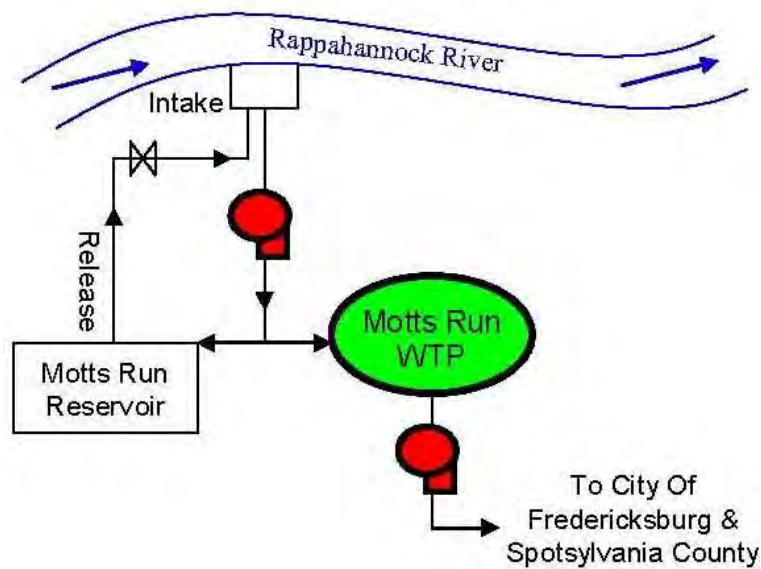


Figure 2-4: Rappahannock River Raw Water Intake & Pump Station Schematic

2.2.4 Spotsylvania County's Rapidan and Rappahannock River Withdrawal Permit

The Hunting Run/Motts Run pumped storage reservoir system is rather unique and is subject to complex and detailed permit conditions. The permit defines withdrawal limitations for both rivers and both reservoirs under various flow conditions. Excepts for the permit are presented below to help illustrate the operating conditions and constraints of the reservoir system.

Permit Conditions: Virginia Water Protection Individual Permit Number 94-1134 pertaining to the City of Fredericksburg, County of Spotsylvania, and the Rapidan and Rappahannock River Intakes. Permit issued on April 20, 2009, with a duration of 15 years.

Part I – Special Conditions; A. Authorized Activities: (1) Permit “authorizes the continued withdrawals necessary to support an 8.0 million gallon per day average withdrawal from the Hunting Run Reservoir and a 6 million gallon per day average withdrawal from the completed transfer of the City of Fredericksburg’s previously existing withdrawal from behind Embrey Dam to a point co-located with Spotsylvania County’s intake on the Rappahannock River near Motts Run, and a 3.4 million gallon per day average withdrawal from the Motts Run Reservoir.

Part I – Special Conditions; C. Water Withdrawal Conditions Rapidan River Intake: (1) The maximum daily withdrawal from the intake on the Rapidan River shall not exceed 24 million

gallons (mg). (2) The permittee may pump from the Rapidan River to the Hunting Run Reservoir provided that after permitted activities defined by this permit, the streamflow measured at the Culpeper gage appropriately corrected with a factor of 1.486 is greater than the Minimum Instream Flow requirements which are define in the permit document. Minimum in stream flowby requirements vary by month and drought emergency conditions.

Part I – Special Conditions; D. Water Withdrawal Conditions Rappahannock River Intake: (1) The maximum daily withdrawal from the intake on the Rappahannock River near Motts Run shall not exceed 30 MG. Nor more than 10 MG per day may be diverted to refill Motts Run Reservoir. (2) Irrespective of the minimum instream flowby requirements, the permittee is allowed to pump 6.0 million gallons per day of instream flow as a result of the completed transfer of the City of Fredericksburg withdrawal plus an amount of water equal to the amount of water being released to augment instream flow from Hunting Run Reservoir. There are no restrictions on the water that is released from Hunting Run Reservoir; the permittee may either recover the water for use at the water treatment plant or use the water to refill Motts Run Reservoir. Augmentation water does not include water released to meet minimum flow requirements in Hunting Run. (3) The permittee may pump from the Rappahannock River to the Motts Run Reservoir or to the Motts Run Water Filtration Plant provided that after permitted activities defined by this permit, the streamflow measured at the Fredericksburg gage is greater than the Minimum In-stream Flow requirements which are define in the permit document. Minimum in-stream flowby requirements vary by month and drought emergency conditions. (5) The maximum annual withdrawal from the Rappahannock River shall not exceed 6368 million gallons [equates to 17.4 MGD average day].

2.3 Self-supplied Users using Groundwater

There are three (3) self-supplied users that withdrawal more than 300,000 gallons per month of groundwater in the planning area, as shown in Figure 2-5. These include the MCK Company (a commercial user), the Indian Acres Club of Thornburg (a non-transient, non-community public water system, PWSID 6177200) and the Wilderness Camping Resorts (a non-transient, non-community public water system, PWSID 6177450).

System capacity and permit limitations for these users are summarized in Table 2-3.

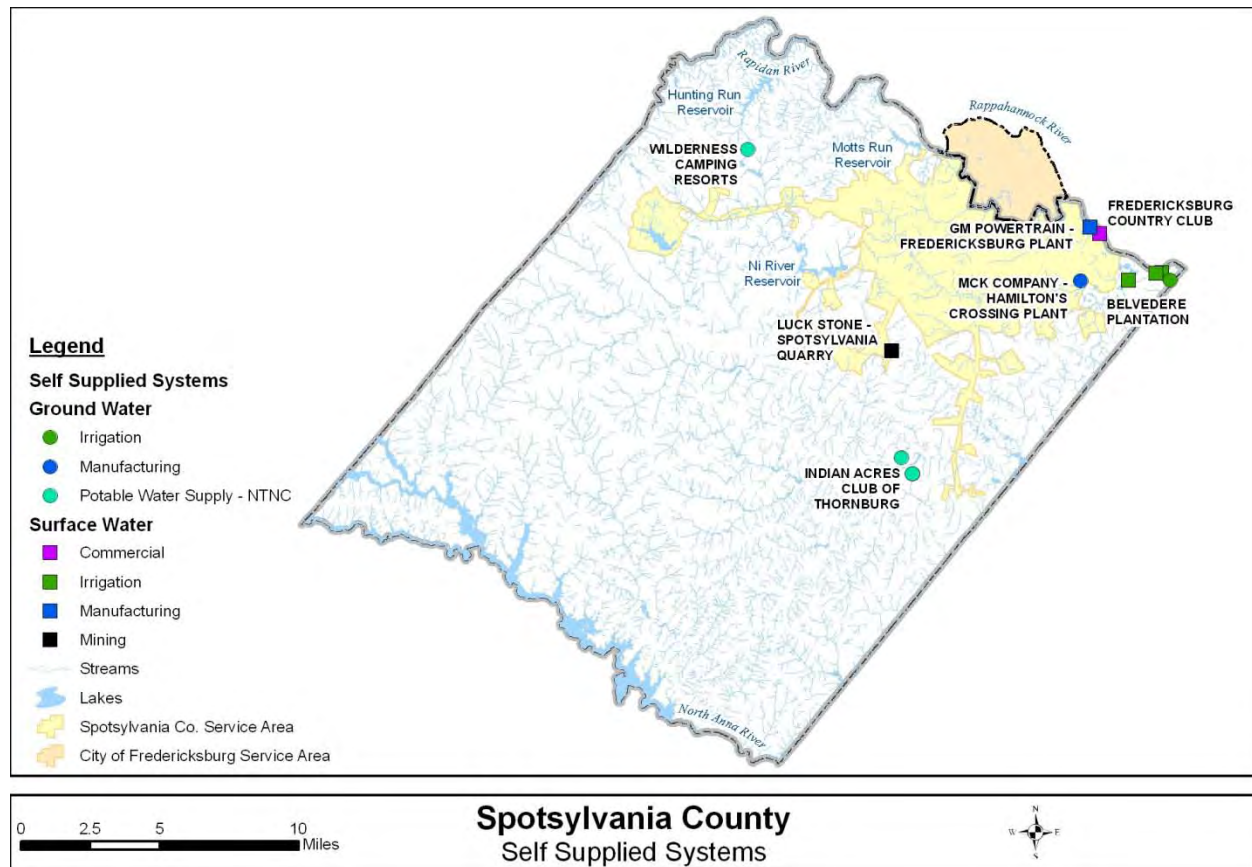


Figure 2-5: Self-supplied Users – Greater than 300,000 gallons per month

Table 2-3: Self-supplied Users on Groundwater			
System Name	No. of Wells	Permitted Capacity (MGD)	Design - Maximum Daily Withdrawal (MGD)
MCK Company	2	350 workers for 8 hr shift	0.856
Indian Acres Club of Thornburg	5	4900 campsites	0.225
Wilderness Camping Resorts	5	0.144	0.189
Total	7		1.270

2.4 Self-supplied Users using Surface Water

There are three (3) self-supplied users that withdrawal more than 300,000 gallons per month of surface water in the planning area, as shown in Table 2-4. These include Fredericksburg County Club (for commercial use), GM Powertrain Group (for manufacturing) and Luck Stone (for mining). It is noted that the GM Powertrain Group facility is no longer in operation, however they continue to send withdrawal reports to DEQ in order to maintain their permitted allocation and are, therefore, identified as a user in this report. Source information for these systems is provided in Table 2-4.

Table 2-4: Self-supplied Users on Surface Water	
System Name	Source
Fredericksburg County Club	Pond
GM Powertrain Group	Rappahannock River
Luck Stone	Ni River
Total	

2.5 Self-supplied Users on Individual Wells

Small self-supplied users (those using less than 100,000 gallons per month) may or may not be known to or monitored by VDH. VDH maintains a list of small self-supplied public water systems (as shown in Table 2-5) but this is not an exhaustive list of all small self-supplied users as it does not include individual residences or businesses that may be self-supplied for non-potable use.

Table 2-5: VDH list of Small Self-supplied Users						
PWSID	Public Water System Name	System Type⁽¹⁾	Service Connection	Population	Source	Est YLD (gpm)
6177005	ANNA POINT MARINA, LLC	NC	4	50	GW	
6177012	LAKE ANNA LODGE	NC	2	200	GW	25
6177044	NATIONAL PARK SERVICE- CHANCELLORSVILLE	NC	4	100	GW	

Table 2-5: VDH list of Small Self-supplied Users

PWSID	Public Water System Name	System Type⁽¹⁾	Service Connection	Population	Source	Est YLD (gpm)
6177180	HIGH POINT MARINA	NC	4	100	GW	
6177230	KOA CAMPGROUND-FREDERICKSBURG	NC	96	25	GW	16
6177240	LAKE ANNA STATE PARK - SECTIONS A & B	NC	3	800	GW	
6177241	LAKE ANNA STATE PARK - CAMPGROUND	NC	53	100	GW	
6177377	208 VARIETY STORE	NC	1	252	GW	
6177035	BERKELEY SCHOOL	NTNC	2	412	GW	
6177175	HAZELWILD FARM EDUCATIONAL FOUNDATION	NTNC	5	200	GW	
6177220	JJWRIGHT EDUC/CULTURAL CTR	NTNC	1	250	GW	16
6177265	LIVINGSTON SCHOOL	NTNC	1	556	GW	18
6177283	NEW LIFE FOR YOUTH	NTNC	4	50	GW	320
6177384	ST. PATRICK CHURCH	NTNC	1	246	GW	
6177405	SPOTSY CO HS (INCL POST OAK MS)	NTNC	2	2000	GW	
6177272	Laurel Hill Funeral Home					22

⁽¹⁾ C = Community Water System

NC = Non-Community Water System

NTNC = Non-Transient Non-Community Water System

Individual residences on private wells are a source of ground water demand that cannot be overlooked, particularly in more rural areas. In the planning area, a large portion of the County population resides outside the community water system service areas and is, therefore, self-supplied via private wells. The City service area covers the entirety of the City leaving only a limited number of older residences on private wells. The number of self-supplied residential users in the planning area was estimated by comparing the total population served by community water systems to the total population in the planning area. In 2009, approximately 78,500 people were self-supplied in the County and 3,000 in the City. The total population of the planning area was estimated at 144,000, thus over half the population is self-supplied. This represents a significant demand that must be accounted for in long-term water supply planning.

2.6 Agricultural Users

The Virginia Tech Agricultural Extension provided information on agricultural water use in the planning area. There are two dairy farms within the county that are estimated to use greater than 300,000 gallons per month. Additionally, there is a third small dairy farm, several beef farms and other various livestock farms, none of which are large enough to exceed a water use of 300,000 gallons per month.

Two irrigation users, Rick's and Van's and Belvedere Plantation, reported withdrawal information to DEQ. Rick's and Van's is located within the community water system service area and withdrawals from the Rappahannock River. Belvedere Plantation is a working plantation that is open to the public and offers educational and recreational opportunities. It is located outside the community water system service area and withdrawals water from three sources; one well, the Rappahannock River and Ruffins Pond.

An additional source of information on agricultural activity is the United States Department of Agriculture (USDA) Census of Agriculture. The 2007 census for Spotsylvania County reports that in 2007 there were 359 farms in Spotsylvania County for a total of 52,230 acres. Of that, 9,910 acres were dedicated to forage, 3,314 acres to corn for grain, 2,914 acres for soybeans, 1,262 acres for corn for silage and 796 acres for wheat for grain. Thus approximately 18,000 acres were used for the top five crop items. The top three primary livestock raised in the county was cattle at 12,062 head, with chicken (layers) accounting for 2,014 and horses at 1,043 head.

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3.0 EXISTING WATER USE INFORMATION (9 VAC 25-780-80)

This section contains information on existing water use within the study area in accordance with the requirements of 9VAC 25-780-80.

3.1 Community Water Systems

As detailed in Chapter 2.0, there are eight (8) community water systems in Spotsylvania County and the City of Fredericksburg including: four (4) surface water systems and four (4) ground water systems. These systems are listed below:

- Spotsylvania County's Ni River Reservoir and associated water treatment plant (PWSID 6177300);
- Spotsylvania County's Motts Run and Hunting Run Reservoirs (system of interconnected, pumped-storage reservoirs) and associated Motts Run Water Treatment Plant (PWSID 6177280);
- The City of Fredericksburg (PWSID 6630050);
- Country Club Estates (PWSID 6177050);
- Glenwood Mobile Home Park (PWSID 6177105);
- Lake Wilderness, Sec 1-11 (PWSID 6177251);
- Lake Wilderness, Sec 12-16 (PWSID 6177252), and
- Lynn Castle Park (PWSID 6177266).

The Spotsylvania County and City of Fredericksburg systems collectively serve the vast majority of the population and are as such the primary users within the planning area. Both are served by the Spotsylvania County Ni and Motts Run Water Treatment Plants. The remaining community water systems are small private systems that serve individual communities.

The tables and discussion below summarize withdrawals by community water systems for the years 2009, 2007 and 2003. The year 2009 represents the most recent year and a typical water use year, while years 2007 and 2003 represent dry and wet years, respectively. Evaluating water use under varied climatic conditions will provide greater understanding of the range of water

demands that have been experienced in the past and will allow for better understanding and projection of water demands in the future.

Table 3-1 summarizes water withdrawals for use by community water systems for the years 2009, 2007 and 2003. It is noted that no data was available for the Lake Wildness and Lynn Castle Park systems for 2003. The total withdrawal for use for a typical year (2009) is approximately 3600 MG, for an average daily withdrawal of 10 MGD. Spotsylvania County accounts for over 97% of the withdrawal in the planning area. Water withdrawals were approximately 12% higher during 2007, the representative dry year, and 10% lower during 2003, the representative wet year. The lack of data for the private systems in 2003 is likely of little consequence, as the mobile home parks that they serve are unlikely to show great variation in water use as a result of changes in precipitation. Such variation is more typical of suburban communities with significant outdoor water use for irrigation of lawns and landscapes.

Table 3-2 summarizes withdrawals by Spotsylvania County and includes withdrawals for storage, as well as withdrawals for use. This table includes withdrawals from and discharges to the Rapidan River for the purposes of storage during wet periods and flow augmentation of the Rappahannock River during dry periods, as well as withdrawals from the Rappahannock to the Motts Run Reservoir or Water Treatment Plant. Thus, this table reflects total water withdrawn from the water resources for both use and storage. Comparison between Table 3-1 and Table 3-2 reveals that despite the increased water use during 2007, the total water withdrawal is less than 2009. Flow augmentation of the Rappahannock River, more than offsets the increased demand, whereas during 2003, a wet year, increased pumping from the Rapidan River for storage in the Hunting Run Reservoir increases total water withdrawal from the rivers. This comparison demonstrates the effectiveness of the pumped storage/augmentation system as a water supply management tool. The system reduces stress and demand on limited dry weather resources, though storage of excess flows available during wet periods and subsequent release of that volume for use during dry periods. Such effective water resources management positions Spotsylvania County well for effectively managing changing precipitation patterns that might result from climate change and other stressors.

Table 3-1: Summary of Community Water System Withdrawals for Use

PWSID	Water System Name	Source Name	2009 Withdrawals				2007 Withdrawals				2003 Withdrawals			
			Avg Daily (MGD)	Max Daily (MGD)	Avg Monthly (MG/Mo)	Total Annual (MG)	Avg Daily (MGD)	Max Daily (MGD)	Avg Monthly (MG/Mo)	Total Annual (MG)	Avg Daily (MGD)	Max Daily (MGD)	Avg Monthly (MG/Mo)	Total Annual (MG)
Municipal Systems														
6177300	NI RIVER WTP	Ni River Reservoir	3.7	4.2	112.1	1345.0	3.4	4.8	104.3	1251.0	2.7	4.8	80.7	968.1
6177280	MOTTS RUN WTP	Rappahannock R. to Motts Run WTP	4.6	9.1	140.5	1686.3	6.9	11.4	210.1	2521.0	6.2	8.8	189.3	2271.8
6177280	MOTTS RUN WTP*	Motts Run Res to WTP or Intake	1.3	17.5	40.6	486.8	0.5	5.4	14.0	168.4	NA	NA	NA	NA
Municipal Community Water System Totals:			9.6		293.2	3518.1	10.8		328.4	3940.4	8.9		270.0	3239.9
Private Systems														
6177105	GLENWOOD MHP	GW	0.02	0.04	0.48	5.80	0.02	0.05	0.54	6.51	ND	ND	ND	ND
6177251	LAKE WILDERNESS, SEC. 1-11**	GW	0.16	0.23	4.74	56.89	0.17	NA	5.17	62.00	0.05	ND	1.58	18.99
6177252	LAKE WILDERNESS, SEC.12-16	GW	0.06	0.09	1.96	23.56	0.07	NA	2.09	25.11	NA	NA	NA	NA
6177266	LYNN CASTLE PARK***	GW	0.01	0.02	0.00	0.00	NA	0.02	0.00	0.00	NA	NA	NA	NA
Private Community Water System Totals:			0.2		7.2	86.3	0.3		7.8	93.6	0.1		1.6	19.0
Municipal and Private Community System Totals:			9.9		300.4	3604.3	11.1		336.2	4034.0	8.9		271.6	3258.9

Notes: *17.5 is the Max Daily pumping from the reservoir to the WTP as reported to DEQ, however, it is noted that that during low flow conditions water may be release from Motts Run to meet the minimum downstream flow requirements of the withdrawal permit. Max flow to the WTP in 2009 was 15.5 MGD

**data for Lake Wilderness, Sec. 1-11 for 2003 is only for Well 5 as presented in the VDH Database.

*** average and max daily for Lynn Castle Park is estimated based on per person use averages for the other mobile home park systems.

Table 3-2: Summary of Spotsylvania County Withdrawals

Source Name	2009 Withdrawals				2007 Withdrawals				2003 Withdrawals			
	Avg Daily (MGD)	Max Daily (MGD)	Avg Monthly (MG/Mo)	Total Annual (MG)	Avg Daily (MGD)	Max Daily (MGD)	Avg Monthly (MG/Mo)	Total Annual (MG)	Avg Daily (MGD)	Max Daily (MGD)	Avg Monthly (MG/Mo)	Total Annual (MG)
Ni River Res	3.7	4.2	112.1	1345.0	3.4	4.8	104.3	1251.0	2.7	4.8	80.7	968.1
Rapidan R to Hunting Run Res.	0.6	6.9	17.9	214.8	0.1	8.9	1.8	22.0	1.2	14.6	36.8	442.2
Hunting Run Res. to Rapidan River*	-0.4	-6.1	-11.4	-137.0	-2.3	-8.8	-71.0	-852.2	0.0	0.0	0.0	0.0
Rappahannock R to Motts Run WTP or Res	4.6	9.1	140.5	1686.3	6.9	11.4	210.1	2521.0	6.2	8.8	189.3	2271.8
Motts Run Res to WTP or Intake	1.3	17.5	40.6	486.8	0.5	5.4	14.0	168.4	ND	ND	ND	ND
Totals	9.9		299.7	3595.9	8.5		259.2	3110.2	10.1		306.8	3682.1

Notes: *Negative numbers indicate a release from Hunting Run Reservoir back to the Rapidan River.

Table 3-3, Figure 3-1 and Figure 3-2 summarize monthly withdrawals for all community water systems. The combined withdrawal for Spotsylvania County and the City of Fredericksburg is the sum of the Rappahannock River, Motts Run Reservoir and Ni Reservoir. The figures effectively illustrate the use of the pumped storage systems for supply management as well as the overall minimal contribution of the private water systems to the total demand.

Table 3-3: Summary of Monthly CWS Withdrawals for Use						
	2009 Withdrawals		2007 Withdrawals		2003 Withdrawals	
	Total Water Use (MG/Mo)	Total Average Monthly (MGD)	Total Water Use (MG/Mo)	Total Average Monthly (MGD)	Total Water Use (MG/Mo)	Total Average Monthly (MGD)
January	276	8.9	281	9.1	257	8.3
February	253	9.0	268	9.6	235	8.4
March	303	9.8	294	9.5	261	8.4
April	291	9.7	308	10.3	273	9.1
May	302	9.7	373	12.0	278	9.0
June	301	10.0	390	13.0	276	9.2
July	341	11.0	421	13.6	315	10.2
August	357	11.5	389	12.6	229	7.4
September	327	10.9	373	12.4	293	9.8
October	310	10.0	362	11.7	296	9.6
November	270	9.0	285	9.5	271	9.0
December	278	9.0	296	9.6	275	8.9
Total Annual (MG)	3,609		4,039		3,259	
Average Monthly (MG/Mo)	301		337		272	
Average Daily (MGD)	9.9		11.1		8.9	

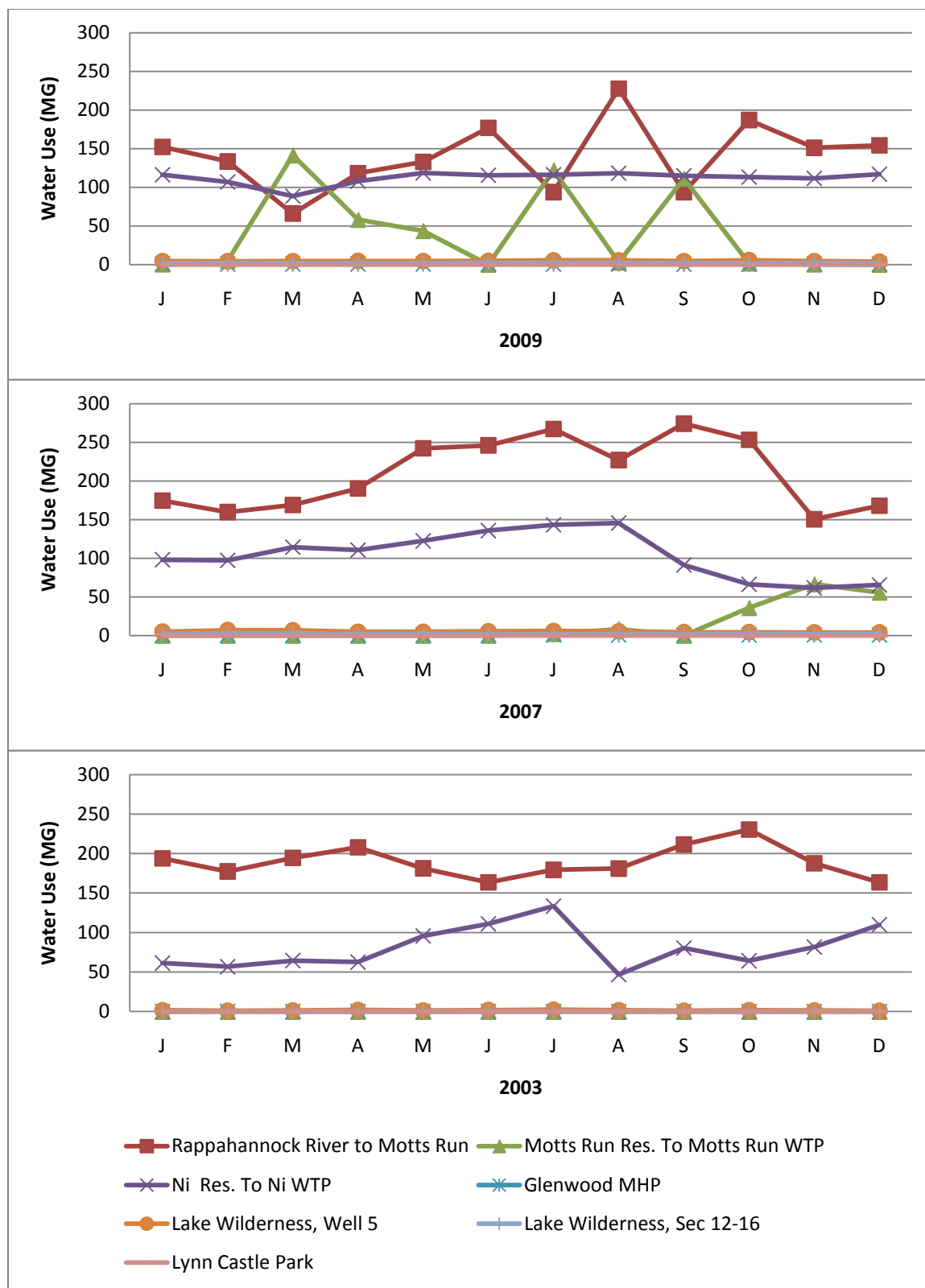


Figure 3-1: Community Water System Monthly Water Use

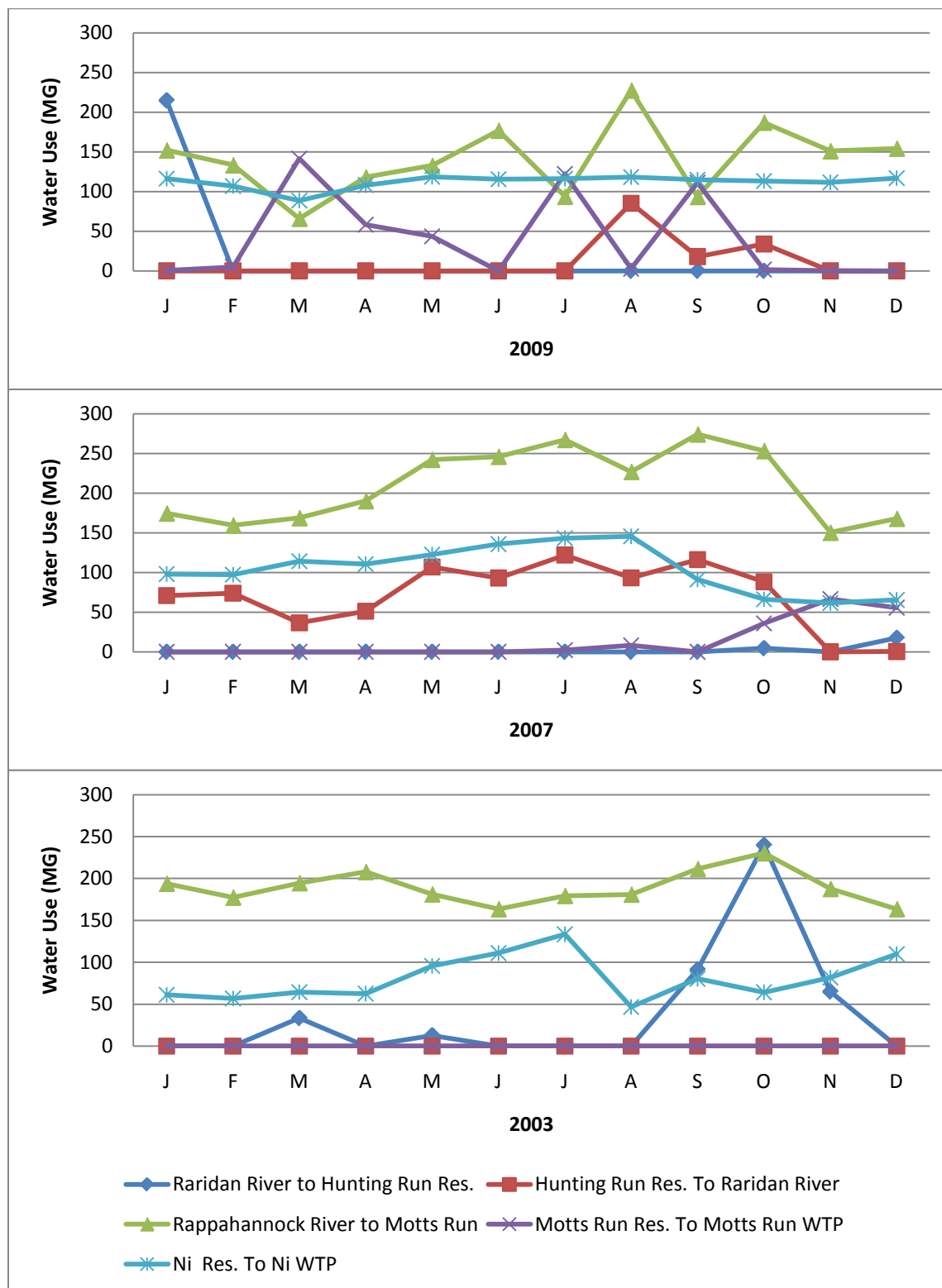


Figure 3-2: Spotsylvania County Monthly Water Withdrawals

3.1.1 Disaggregated Use

Disaggregated water use for all community water systems is shown in Table 3-4 and summarized in Figure 3-3. It is noted that the private systems that serve mobile home parks were assumed to have only residential users. Residential use accounts 58% of the total use, followed by commercial, institutional and light industrial which accounts for 29%. The dominance of the residential demand suggests that as the County and City consider demand management initiatives, they should consider focusing on reducing residential demand.

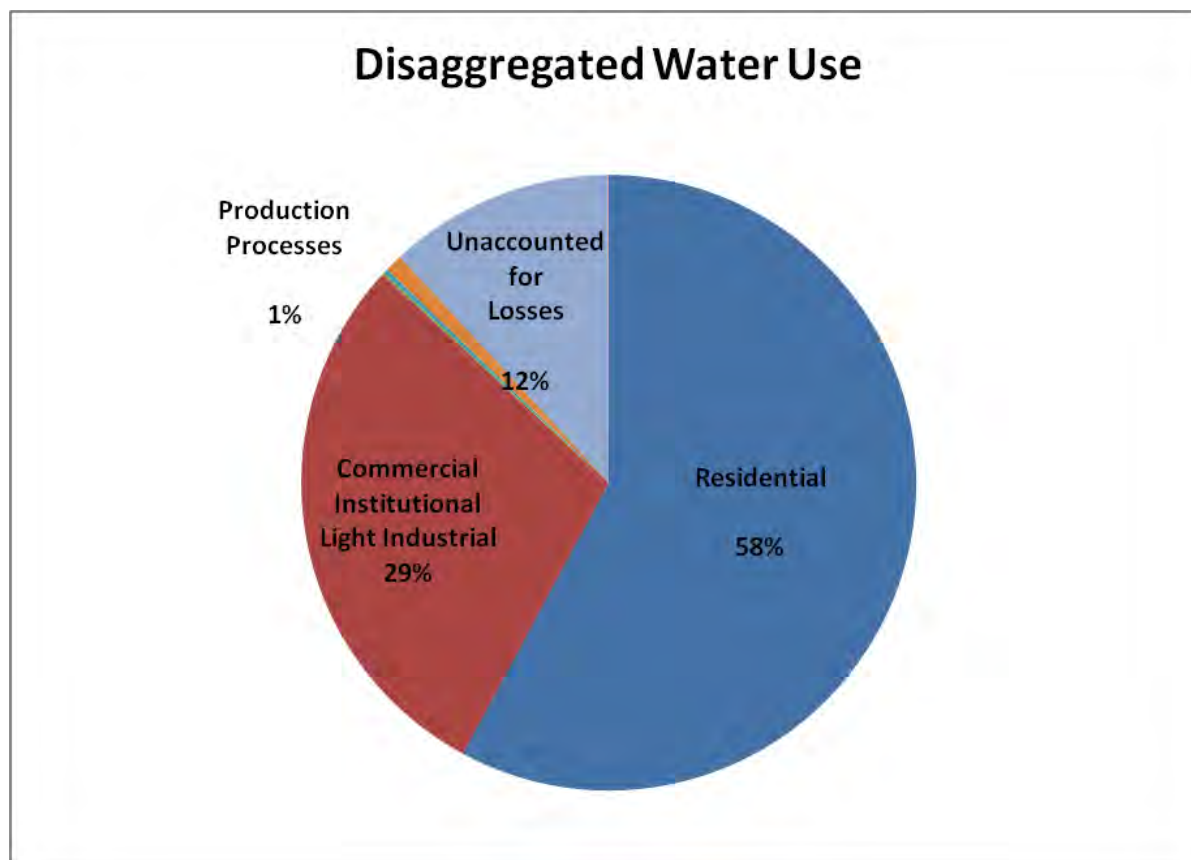


Figure 3-3: Disaggregated Water Use

3.1.2 In-stream Beneficial Use

The Spotsylvania intakes on the Rapidan and Rappahannock Rivers are subject to permit restrictions to limit negative impacts of the withdrawals on other in-stream uses. The Rapidan River is considered worthy of scenic river designation, is a potential anadromous fish passage and is a recreational resource. The Rappahannock River is a designated scenic river, a confirmed

anadromous fish passage, a recreational resource and is used for waste assimilation from various downstream wastewater treatment facilities.

The minimum in-stream flow (MIF) requirements in the withdrawal permits are designed to ensure that the withdrawal for public water supply does not inhibit these other beneficial uses.

Table 3-4: 2009 CWS Disaggregated Use

PWSID	Water System Name	System Total (MGD)	Use Category								
			Residential (MGD)	Commercial Institutional Light Industrial CIL (MGD)	Heavy Industrial (MGD)	Military (MGD)	Other (MGD)	Production Processes (MGD)	Unaccounted for Losses (MGD)	Sales to Other CWSs	
										Amount Sold (MGD)	System Name
6177280 & 6177300	Spotsylvania County - Motts Run and Ni River WTPs	9.22	4.38	1.49	0.00	0.00	0.02	0.08	0.58	0.01	County Club Estates
										2.67	City of Fredericksburg
6630050	City of Fredericksburg	2.67	0.96	1.18	0.01	0.00	0.00	0.00	0.51	0.00	
	All Private CWS*	0.24	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Total Use By Category (for All Community Water Systems)**		9.46	5.34	2.67	0.01	0.00	0.02	0.08	1.09	0.01	

*For private CWSs it is assumed that all use is residential since these are small systems that serve individual communities.

** The City's "System Total Use" is not included in sum of all CWSs because it is included in the Spotsylvania County System Total Use.

3.2 Self-supplied Users

As presented in Chapter 2.0 there are there are six (6) self-supplied users and two (2) dairy operations that use greater than 300,000 gallons per month of surface water and/or groundwater. Table 3-5 provides summary information on the non-agricultural self-supplied users withdrawing greater than 300,000 gallons per month. With the average annual demand ranging from approximately 0.14 to 0.24 MGD (note need additional data on one system to finalize these numbers), these systems account for a relatively small percentage of the overall demand as compared to the community water systems discussed in Section 3.1.

VDH maintains the List of Waterworks Users and Operators, which includes small self-supplied public water suppliers (those using less than 300,000 gallons per month). However, this is not an exhaustive list of all water users as it does not include individual residences or small businesses/industries that withdrawal water for non-potable use. For Spotsylvania County, the VDH list contains 16 non-community and/or non-transient/non-community systems that serve facilities such as businesses, schools, churches, marinas and camp grounds. No use data is available for these systems.

Annual average water use by small self-supplied residential users was estimated by comparing the total population served by community water systems to the total population in the planning area. In 2009, approximately 35,000 people were self-supplied in the County and 3,000 in the City. A per capita demand factor of 110 gallons per person per day was applied to estimate the residential demand. This factor is based on the calculated County per capita use for the past three years. The annual average residential withdrawal was then estimated at 3.8 MGD for 2009. Average annual withdrawals for 2007 and 2003 were estimated based on the community water system use ratios for typical to dry and typical to wet years, respectively. This resulted in estimated residential withdrawals of 4.2 MGD in 2007 and 3.4 MGD in 2003. This self-supplied residential demand is attributed primarily to residences in the large extent of rural area within the County, with only small percentages likely attributable to residences within the City or County service areas.

Table 3-5 shows that the residential self-supplied users have a far greater demand than the self-supplied businesses/institutions using greater than 300,000 gallons per month. Though no use data is available for the self-supplied businesses/institutions users less than 300,000 gallons per

month, it can be concluded that these will also account for only a very small portion of the demand.

Table 3-5: Summary of Self-Supplied User Withdrawals (Non-Ag)						
Water System Name	Use Category	Source Name	Within CWS Service Area?	Estimated Annual Average Withdrawal (MGD)		
				2009*	2007	2003
Ground Water						
Po River Water and Sewer Company - Indian Acres Club of Thornburg	NTNC PWS	5 wells	N	0.06	0.06	0.05
Recreational Resorts, Ltd. - Wilderness Camping Resorts	NTNC PWS	5 wells	N	0.04	0.04	0.04
MCK Company	COM	2 wells	Y	0.00	0.02	0.01
Total Ground Water Withdrawals				0.10	0.12	0.11
Surface Water						
Fredericksburg County Club	COM	POND	Y	0.04	0.11	0.06
GM Powertrain Group	MAN	Rappahannock River	Y	0.00	0.00	0.02
Luck Stone	MIN	Ni River	Y	0.00	0.01	0.00
Total Surface Water Withdrawals				0.04	0.12	0.08
Self-Supplied Residential Users			maybe	3.8	4.2	3.4
Total Self-Supplied User Withdrawals (Non-Ag)				3.9	4.4	3.6

Notes: * Missing data for one well for the Po River Water and Sewer Company in 2009, this was estimated as the average of the withdrawals reported for 2003 and 2007.

Withdrawal for agricultural use is another source of self-supplied demand. Table 3-6 presents summary information for agricultural withdrawals greater than 300,000 gallons per month in the planning area. The Virginia Tech Agricultural Extension provided information on the two dairy farms. The information on the two irrigation users was retrieved from the DEQ's database. The Virginia Tech Agricultural Extension indicated that in addition to these to large dairy farms, there is another small dairy farm, several beef farms and other various livestock farms, none of which are large enough to exceed a water use of 300,000 gallons per month.

An additional source of information on agricultural activity is the United States Department of Agriculture (USDA) Census of Agriculture. The 2007 census for Spotsylvania County reports that in 2007 there were 359 farms in Spotsylvania County for a total of 52,230 acres. Of that, 9,910 acres were dedicated to forage, 3,314 acres to corn for grain, 2,914 acres for soybeans, 1,262 acres for corn for silage and 796 acres for wheat for grain. Thus approximately 18,000 acres were used for the top five crop items. The top three primary livestock raised in the county was cattle at 12,062 head, with chicken (layers) accounting for 2,014 and horses at 1,043 head.

Table 3-6: Summary of Self-Supplied Agricultural Withdrawals						
User Name	SOURCE TYPE:		USE TYPE:	Estimated Annual Average (MGD)		
	Ground Water	Surface Water	IRR? (Y/N)	2009	2007	2003
Within Community Water System (Municipal & Private) Service Areas						
Richard Debernard - Risks and Vans		Rappahannock River	Y	ND	ND	ND
Within Community Water System Service Area Water Use Totals (MGD):				0.00	0.00	0.00
Outside Community Water System (Municipal & Private) Service Areas						
Dairy Farm 1	Private Well		N	0.01	0.01	0.01
Dairy Farm 2	Private Well		N	0.01	0.01	0.01
McKendree R Fulks – Belvedere Plantation	Market Well		Y	0.00	0.00	0.00
McKendree R Fulks – Belvedere Plantation		Rappahannock River Drip Pump	Y	0.06	0.00	0.00
McKendree R Fulks – Belvedere Plantation		Rappahannock River	Y	0.03	0.07	0.00
McKendree R Fulks – Belvedere Plantation		Ruffens Pond	Y	0.00	0.00	0.00
Outside Community Water System Service Area Water Use Totals (MGD):				0.12	0.09	0.02
Estimated Total Agricultural Useage (MGD):				0.12	0.09	0.02

3.3 Total Water Use

Total annual average water use for the County and City is estimated at 13.9 MGD, 15.6 MGD and 12.5 MGD, for 2009, 2007 and 2003 respectively as presented in Table 3-7. In all years the combined community water system and self-supplied residential use account for at least 96% of

the demand. Thus from a regional planning perspective it will be important to understand growth patterns both within and outside of the County's service area.

Table 3-7: Estimated Total Water Use			
	2009	2007	2003
	Annual Average (MGD)	Annual Average (MGD)	Annual Average (MGD)
<i>Municipal Community Water Systems</i>	9.6	10.8	8.9
<i>Private Community Water Systems</i>	0.2	0.3	0.1
<i>Self-Supplied Users >300,000 gal/mon. (Non-Ag)</i>	0.1	0.2	0.2
<i>Self-Supplied Residential Users</i>	3.8	4.2	3.4
<i>Self-Supplied Agricultural Users >300,000 gal/mon.</i>	0.1	0.1	0.0
<i>Total Water Use in Planning Area</i>	13.9	15.6	12.5

4.0 EXISTING RESOURCE CONDITIONS (9 VAC 25-780-90)

This section contains information on existing resources within the study area in accordance with the requirements of 9VAC 25-780-90.

4.1 Geologic Conditions

The geology of Spotsylvania County and the City of Fredericksburg is shown in Figure 4-1³. There are four different types of underlying rock in the planning area. Neogene sedimentary rocks are found in the eastern portion of the County and in the City of Fredericksburg. The center of the County overlies of Lower Mesozoic sedimentary rock, which is the predominant formation in the study area. The southern corner of the county is composed of Middle Proterozoic gneiss, while the north western border consists of Upper Proterozoic and Lower Paleozoic sedimentary rocks.

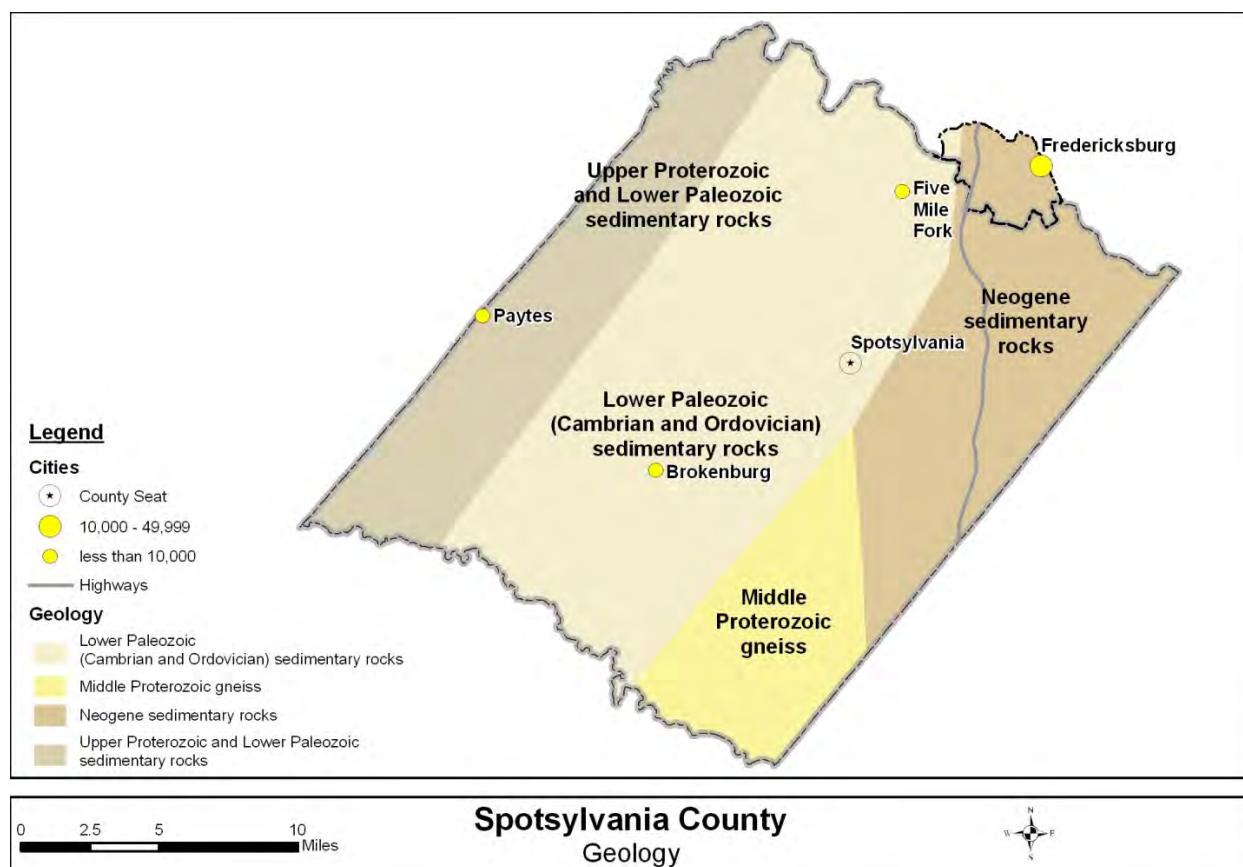


Figure 4-1: Geology

³ Based on geographic data retrieved from the United States Geological Survey (USGS) (<http://pubs.usgs.gov/atlas/geologic/48States/>, accessed June 5, 2006).

4.2 Hydrologic Conditions

The average annual rainfall for Spotsylvania County and City of Fredericksburg is 42 – 44 inches as shown in Figure 4-2⁴.

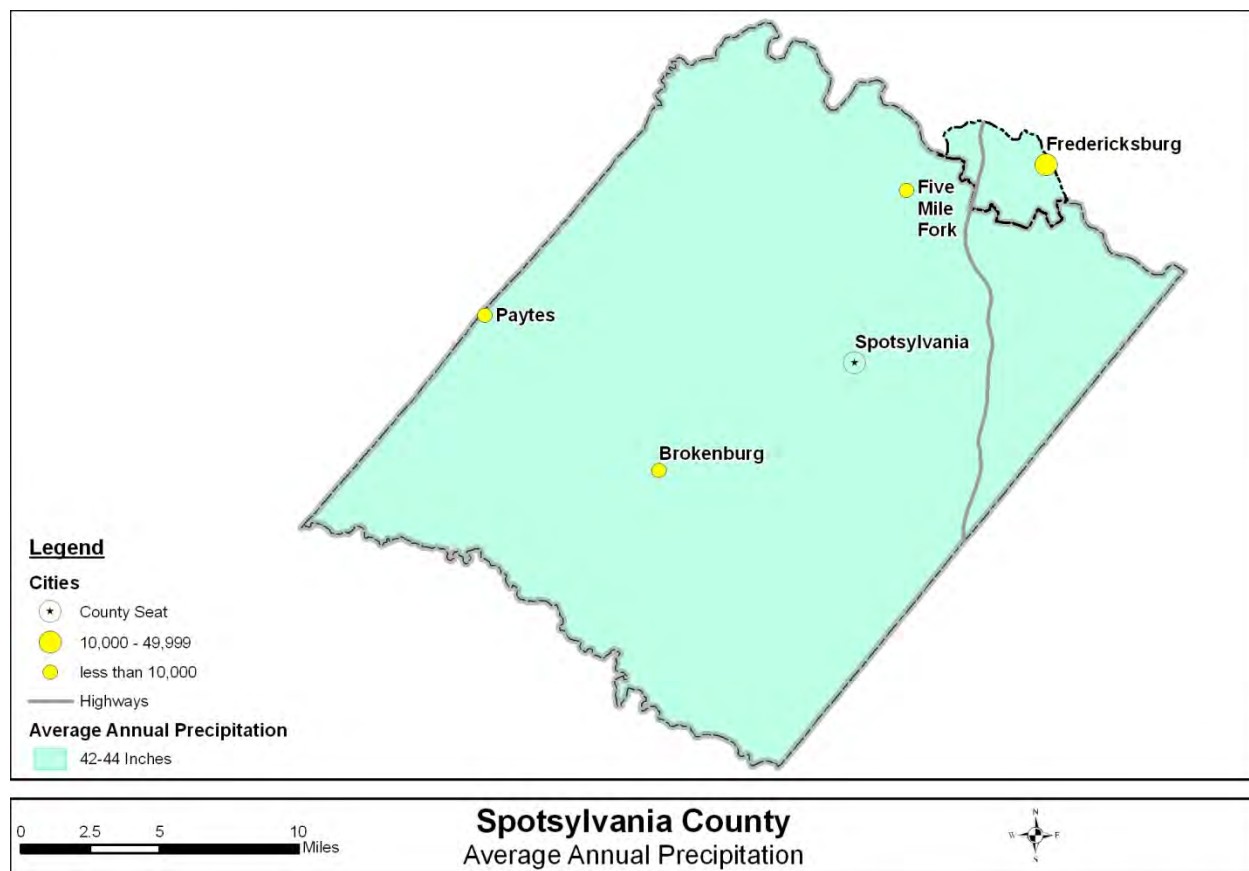


Figure 4-2: Annual Average Precipitation

There are three Southeast Regional Climate Center weather stations located in or adjacent to Spotsylvania County: in the City of Fredericksburg, Partlow and Corbin (Caroline County near eastern corner of Spotsylvania County). Historical climate summary statistics for these stations are presented Table 4-1⁵. The data suggests that there may be some variation in temperature and precipitation from the eastern to the southern portions of the county. The range of minimum and maximum temperature and precipitation is wider in Partlow than in Fredericksburg and Corbin, which have similar conditions.

⁴ Based on geographic data retrieved from the National Atlas

(<http://nationalatlas.gov/atlasftp.html?openChapters=chpclim#chpclim>, accessed 08/08/2010).

⁵ Based on climate data from SERCC (http://www.sercc.com/climateinfo/historical/historical_va.html, accessed 08/02/2010).

Table 4-1: Climate Summary

Site	Period of Record	Max Average Maximum Month Temp (°C)	Min Average Minimum Month Temp (°C)	Average Annual Precipitation (inches)
Fredericksburg	4/1893 – 3/1997	88.4	24.9	41.26
Partlow	6/1952 – 12/1976	89.0	20.6	45.2
Corbin	1/1958 – 12/2009	86.9	24.1	42.93

The aquifers present in Spotsylvania County and City of Fredericksburg are shown in Figure 4-3⁶. Two major aquifers underlie the study area, the Northern Atlantic Coastal Plain Aquifer in the eastern corner of the county and the Piedmont and Blue Ridge Crystalline-Rock Aquifer throughout the rest of the study area.

The Northern Atlantic Coastal Plain Aquifer system is a wedge-shaped mass of semi-consolidated to unconsolidated sediments that thickens toward the ocean and rests on a surface of crystalline rock. These permeable materials provide ample opportunity for groundwater storage, more so than in the other provinces in the state; hence there is significant groundwater use in the Coastal Plain. Two groundwater systems comprise the Coastal Plain, one shallow and one deep. The shallow system serves as the groundwater source to many domestic wells and small community systems, but is unconfined and therefore susceptible to infiltration of pollutants from the surface. The deeper, confined aquifer system is the principal source of major groundwater withdraws.

The Piedmont and Blue Ridge Crystalline-Rock Aquifer is comprised of igneous and metamorphic rock. Spaces between the individual mineral crystals of crystalline rocks are microscopically small, few, and generally unconnected; therefore, porosity is insignificant. These igneous and metamorphic rocks are permeable only where they are fractured. The size and number of fractures decrease with depth, therefore the greatest potential for water groundwater supply is within a few hundred feet of the surface. Groundwater yields can be quite large in areas where fracture and fault systems are extensive.

⁶ Based on geographic data retrieved from the National Atlas
(<http://www.nationalatlas.gov/atlasftp.html?openChapters=chpwater#chpwater>, accessed 06/05/2006).

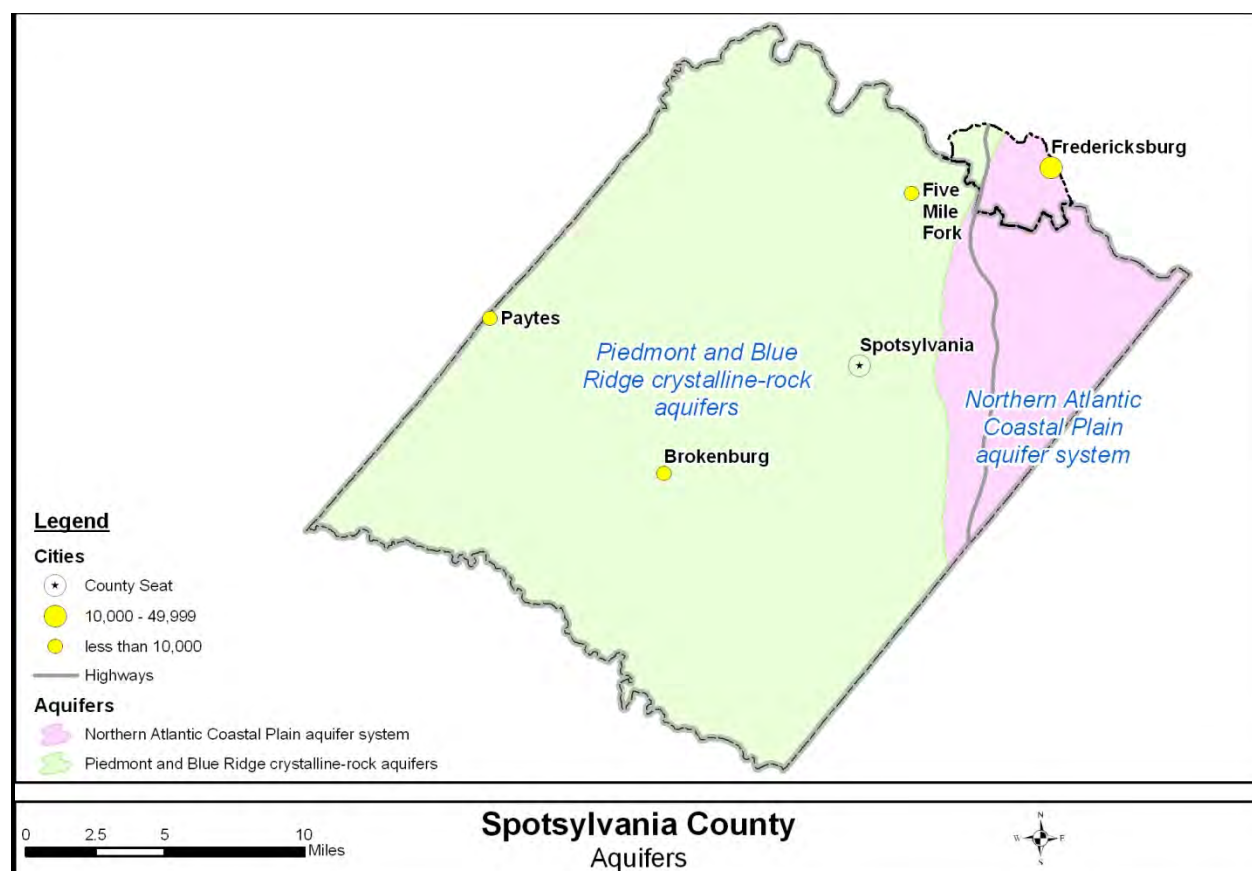


Figure 4-3: Aquifers

4.3 Watersheds

Spotsylvania County and City of Fredericksburg are in the York and Rappahannock River Basins. Most of the Spotsylvania County lies in the York River Basin (75%) with only the northeastern portion of the county and the City of Fredericksburg falling into the Rappahannock River Basin (25%). Figure 4-4 shows the major watersheds (Hydraulic Unit Code (HUC) 8 – HUC8) and sub-watersheds (HUC14) within the county and city⁷. Within the Rappahannock River Basin are the Rapidan-Upper Rappahannock and Lower Rappahannock watersheds. Within the York River Basin are the Mattaponi and Pamunkey watersheds.

⁷Based on data obtained from <http://datagateway.nrcs.usda.gov/GDGHome.aspx>, accessed 02/24/2010.

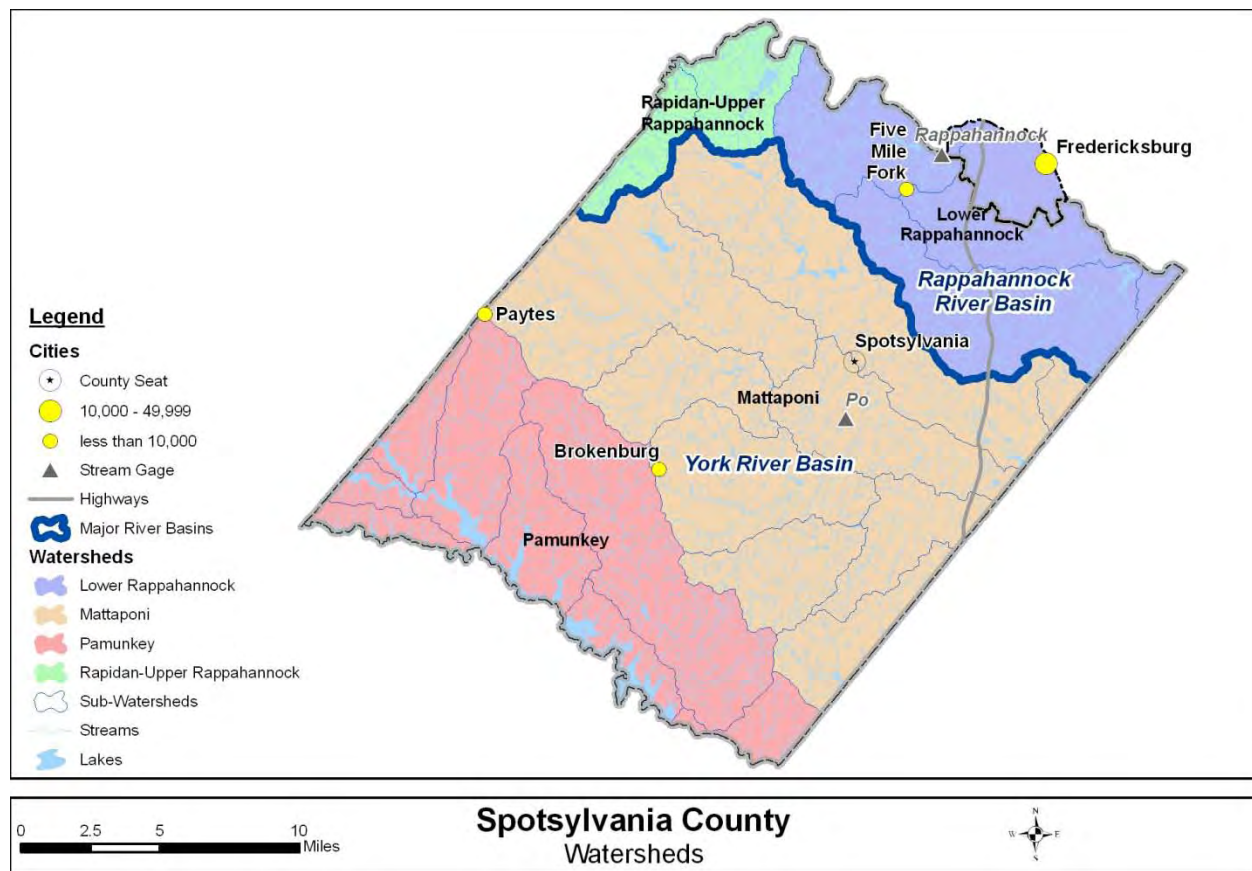


Figure 4-4: Watersheds

As shown on Figure 4-4, there are two USGS Gauging Stations in the planning area:

- 1668000 Rappahannock River near Fredericksburg, VA located 0.7 miles downstream of Motts Runs Reservoir and 5.3 miles upstream of Fredericksburg; and
- 01673800 Po River near Spotsylvania, VA located 2.0 miles south of Spotsylvania and 4.8 miles downstream from Gladys Run.

River flow statistics for these gages are summarized in Table 4-2⁸.

⁸ Based on data obtained from <http://wdr.water.usgs.gov/wy2009/search.jsp>, accessed 8/2/2010.

Table 4-2: Flow Statistics (USGS Water Data Report 2009)		
	Rappahannock 1668000	Po 01673800
Period of Record	1907 - present	1962 - Present
Annual mean flow (cfs)	1.674	75.3
Highest annual mean flow (cfs)	3,292	164
Lowest annual mean flow (cfs)	440	11.8
Maximum peak flow (cfs)	127,000	10,900
Instantaneous low flow (cfs)	5.0	0.0

Spotsylvania County is not in a Groundwater Management Area, and there are no groundwater monitoring wells in the county.

4.4 Natural Heritage Resources

Natural Heritage Resources are defined by the Virginia Department of Conservation as “habitat of rare, threatened, or endangered plant and animal species, rare or state significant natural communities or geologic sites, and similar features of scientific interest”. Of particular significance when developing water supplies is consideration and maintenance of aquatic habitats of rare, threatened, or endangered plant and animal species.

Spotsylvania County and the City of Fredericksburg are home to at least 735 different wildlife species as documented in the Biota of Virginia database administered by the Virginia Department of Game and Inland Fisheries. Over thirty (30) of these are listed as Endangered, Threatened or Species of Concern by the Commonwealth of Virginia and/or the U.S. Fish and Wildlife Service. Among those listed are the following:

- Dwarf Wedgemussel - federal and state endangered species,
- Yellow Lance mussel - federal and state species of concern, and
- Green Floater - state threatened species.

All development projects require state and national clearance from various wildlife protection agencies. If threatened or endangered species or their habitats may be disturbed, a project will require mitigation activities. Therefore, the potential for such disturbance should be considered when evaluating alternative water supplies for development.

Though not listed as endangered or threatened, anadromous fish and their habitats should be considered when developing water supplies. Anadromous fish migrate to spawn in freshwater after spending most of their life in an estuary or ocean. Construction of dams or impoundments that would inhibit fish passage should be avoided in waterways that support anadromous fish. Figure 4-5 shows the waterways in Spotsylvania County and the City of Fredericksburg that are confirmed as providing passage and spawning ground for anadromous fish as well as those that show potential for such use⁹. Species that use these waterways include American Shad, Striped Bass, Blueback Herring, Hickory Shad, Alewife and Yellow Perch.

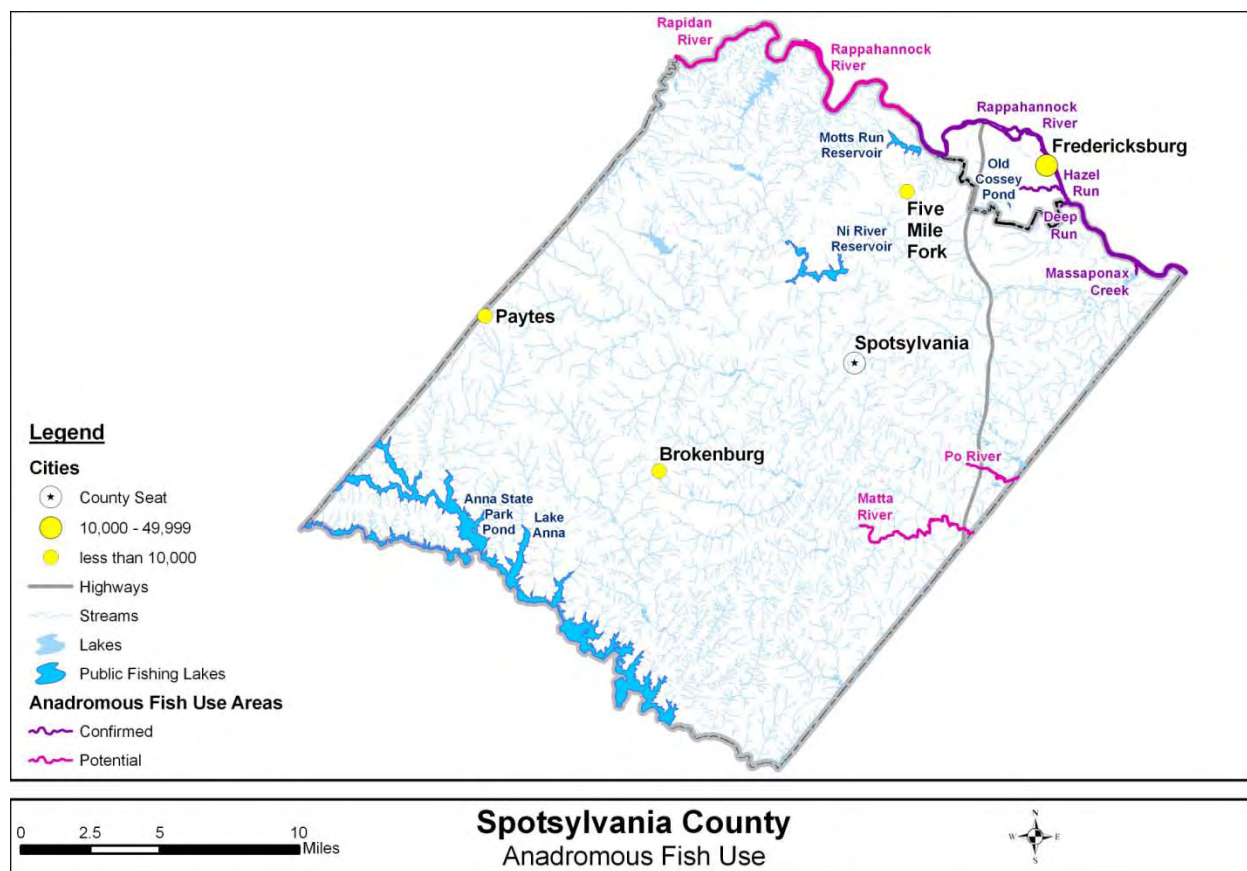


Figure 4-5: Anadromous Fish Use

4.5 Sites of Historic or Archaeological Significance

The National Register of Historic Places is the Nation's official list of cultural resources worthy of preservation. Authorized under the National Historic Preservation Act of 1966, the National

⁹ Based on data from the Commonwealth of Virginia at <http://www.dgif.virginia.gov/gis/datadownload.asp>, accessed August 10, 2010).

Register is part of a national program to coordinate and support public and private efforts to identify, evaluate, and protect our historic and archeological resources. The National Register is administered by the National Park Service, which is part of the U.S. Department of the Interior.

The National Register of Historical Places declared seventeen (17) sites in Spotsylvania County and twenty-five (25) sites in the City of Fredericksburg as being sites of historical significance. The historical places in planning area for which geographic data are available are shown on Figure 4-6. This map also shows Historical District Areas and National Park Service Lands in Spotsylvania County. The information presented in this map was provided by Spotsylvania County in the form of a GIS shapefile. The development of water resources in known historic sites would be limited due to the possibility of damaging the cultural and historical resources and should be considered only after other sites have been excluded from consideration.

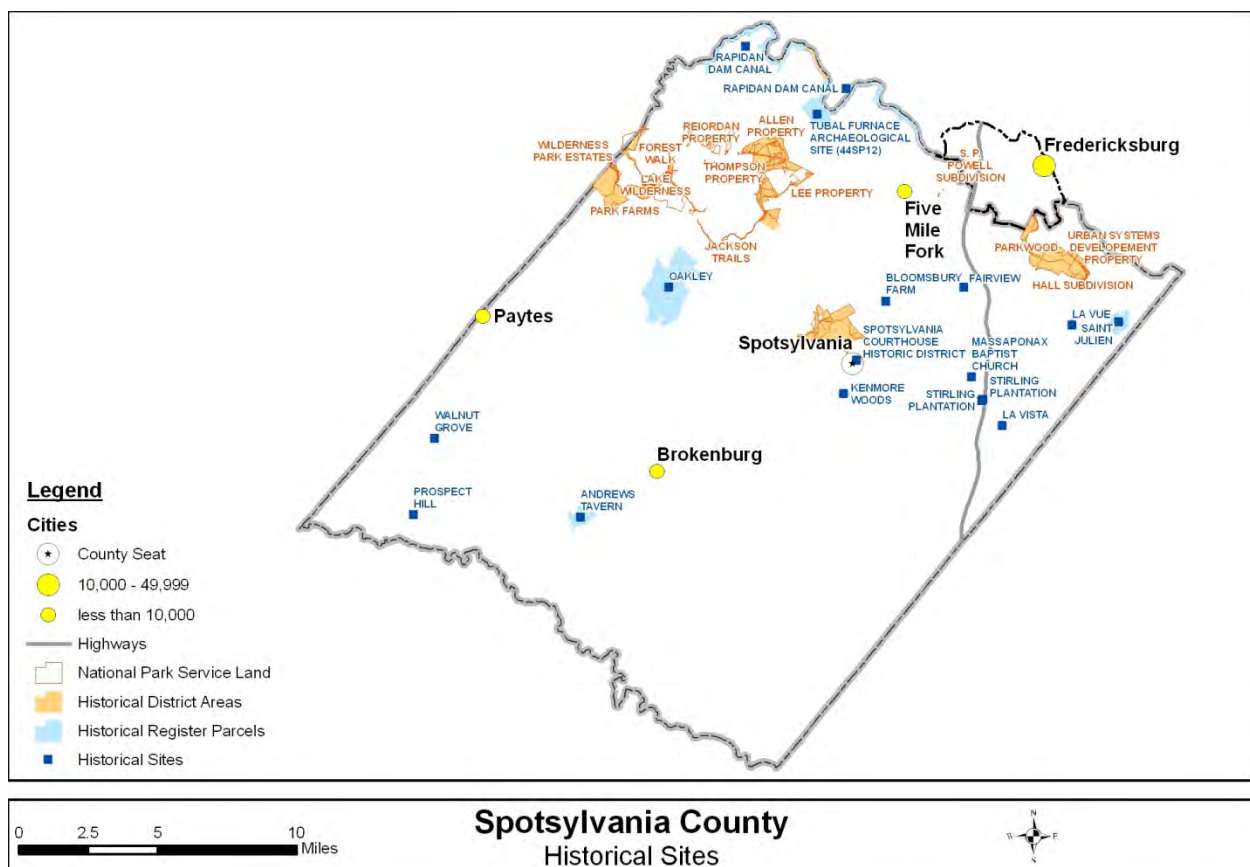


Figure 4-6: Historical Sites

4.6 Unusual Geologic Formations or Special Soil Types

Figure 4-7 shows the soil types found in Spotsylvania County and City of Fredericksburg along with the order and suborder of soils associated with this area¹⁰. Characteristics of each soil type as per the National Resources Conservation Services (NRCS) are presented below.

4.6.1 Alfisols, Udalfs

Udalfs, which have an udic moisture regime, are of large extent in the United States. They form a belt extending from Minnesota through Wisconsin, Michigan, Indiana, and Ohio and ending in New York State. Another large area of Udalfs begins in southern Iowa and extends through Missouri, Illinois, and the States to the south bordering the Mississippi River. All Udalfs are believed to have supported forest vegetation at some time during development.

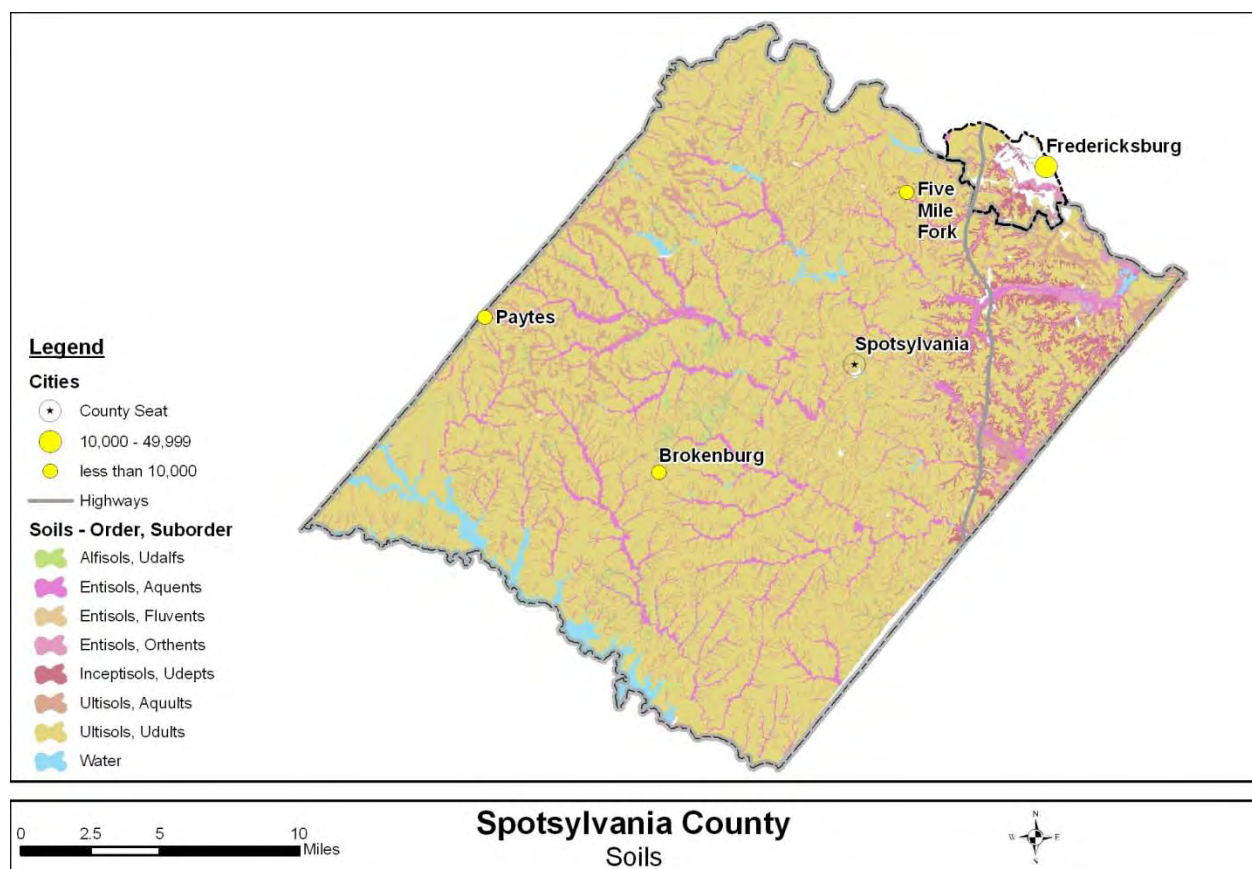


Figure 4-7: Soil Types

¹⁰ Collected from the United States Department of Agriculture (<http://soildatamart.nrcs.usda.gov/State.aspx>, accessed 08/04/2010).

4.6.2 Entisols, Aquents

Aquents, or the wet Entisols, are widely distributed. They dominate some of the delineations along the southern Atlantic and gulf coasts and on the flood plains along the Mississippi River and along other rivers and streams. Some Aquents are forming, mostly in sandy deposits, in other parts of the country. Most of the soils are forming in recent sediments. They support vegetation that tolerates permanent or periodic wetness. They are used mostly as pasture, cropland, forest, or wildlife habitat.

4.6.3 Entisols, Fluvents

Fluvents are the more or less freely drained Entisols that formed in recent water-deposited sediments on flood plains, fans, and deltas along rivers and small streams throughout the country. Some of the largest areas are on the flood plains along the Mississippi River. Most Fluvents are frequently flooded, unless they are protected by dams or levees. Stratification of the materials is normal. Most Fluvents are used as rangeland, forest, pasture, or wildlife habitat. Some are used as cropland.

4.6.4 Entisols, Orthents

Orthents are mainly in the Western States. They are commonly on recent erosional surfaces. Orthents are used mostly as rangeland, pasture, or wildlife habitat.

4.6.5 Inceptisols, Udepts

Udepts are mainly freely drained Inceptisols that have an udic or a perudic moisture regime. They are most extensive in the Appalachian Mountains, on the Allegheny Plateau, in northeastern Minnesota, and in Oregon. Most of the soils currently support or formerly supported forest vegetation, but some support shrub or grass vegetation. The vegetation was mostly coniferous forest in the Northwest and mixed or hardwood forest in the Eastern States. Most are used as forest or have been cleared and are used as cropland or pasture.

4.6.6 Ultisols, Aquults

Aquults are the Ultisols in wet areas where groundwater is very close to the surface during part of each year, usually in winter and spring. They are on the coastal plains, particularly along the

Atlantic Ocean and the Gulf of Mexico. Slopes are gentle. Most of the soils formerly supported forest vegetation. Many still support forest vegetation.

4.6.7 Ultisols, Udults

Udults are the more or less freely drained, relatively humus poor Ultisols that have an udic moisture regime. They are in southern and eastern parts of the country. Most of these soils currently support or formerly supported mixed forest vegetation. Many have been cleared and are used as cropland, mostly with the use of soil amendments.

4.6.8 Acid Sulfate Soil

Acid sulfate soil is not a formal classification but represents any soil or sediment that is comprised of materials with high iron sulfide content, such as pyrite. When these materials are disturbed during construction and exposed to the air the iron sulfide is oxidized releasing sulfuric acid and iron, aluminum or other heavy metals. The acidic soil and high metal concentrations are very toxic to the aquatic environment, can degrade concrete foundations and cause other complications. Acid sulfate soil may be present in the eastern portion of the County. Appropriate testing and remediation will be required to develop these areas.

4.7 Flood Plains

FEMA has yet to digitize the flood plain mapping for Spotsylvania County and City of Fredericksburg. Figure 4-8 shows the 100-year flood plain as provided by Spotsylvania County and the City of Fredericksburg¹¹. In general, development in the 100-year flood plain should be avoided to prevent erosion and scouring of embankments located in the flood plain. Also, construction of an embankment in the 100-year flood plain could raise the level of the 100-year flood and negatively impact the upstream properties.

¹¹ The information presented in this map was provided by the County and the City in the form of GIS shapefiles.

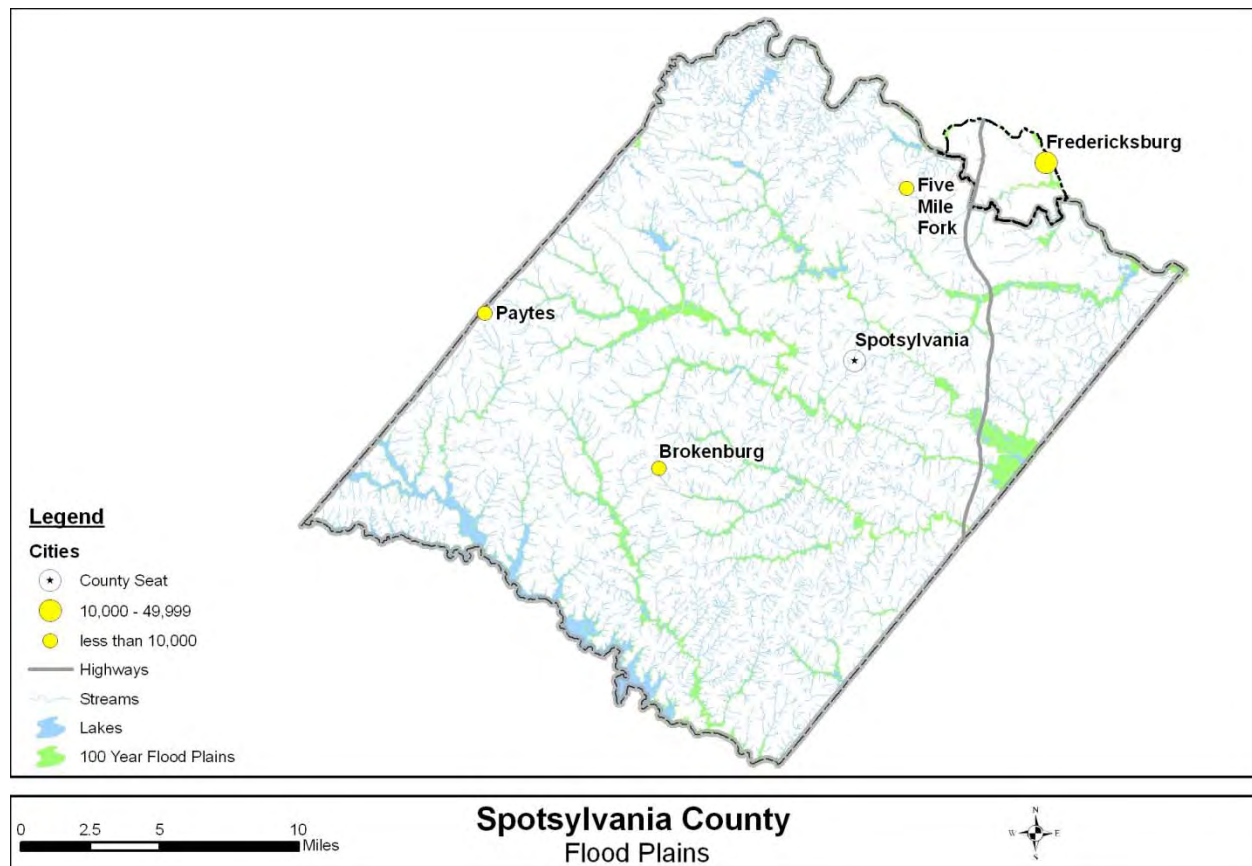


Figure 4-8: Flood Plains

4.8 River Segments that have Recreational Significance, Including State Scenic River Status

The Scenic River designation constitutes official recognition of the natural, scenic, historic and recreational values of some of Virginia's most valuable river resources and provides them with a measure of protection not afforded other rivers. Figure 4-9 shows the waterways in Spotsylvania County and City of Fredericksburg that have been designated as scenic rivers or have been identified as having the potential for such designation by the Virginia Department of Conservation and Recreation¹². The Rappahannock River from its headwaters to the Route 3 Bridge at Ferry Farm is the only designated Scenic River in the county. The Rappahannock River from Ferry Farm to the Chesapeake Bay, the Rapidan River from Germanna Ford to its confluence with the Rappahannock River, and the North Anna River from Lake Anna to Route

¹²Based on data from the Commonwealth of Virginia at http://www.dcr.virginia.gov/natural_heritage/cldownload.shtml, accessed 08/03/2010.

738- Anderson Bridge have all been identified as having the qualities of a Scenic River and/or being worthy of future evaluation and consideration.

The National Rivers Inventory (NRI) is a national listing that designates river segments as being worthy of more than local or regional recognition based on their natural or cultural significance. NRI designated the Rappahannock River upstream of Fredericksburg, the Rapidan River from north of Indian Town to the Rappahannock, and the North Anna River from 15 miles north of the Morris Bridge to Lake Anna. These segments are generally consistent with the Virginia Scenic River segments.

In long-term water supply planning, it will be important to consider these state and national designations and to ensure that any water supply development does not negatively impact these recreational and cultural resources.

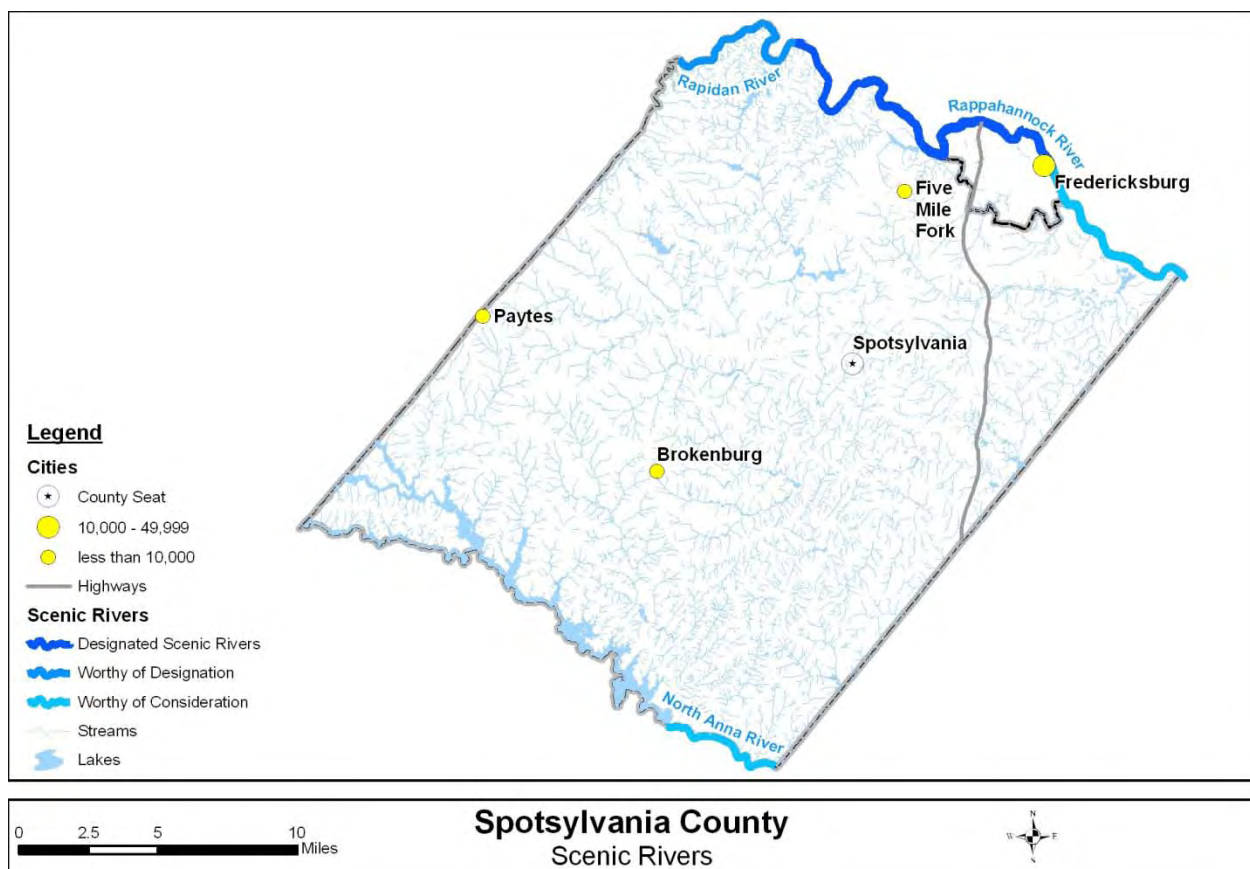


Figure 4-9: Scenic Rivers

4.9 Wetlands

Figure 4-10 shows the location of wetlands in Spotsylvania County and City of Fredericksburg, as recorded in the U.S. Fish and Wildlife Services' National Wetland Inventory¹³ (NWI). Wetlands are to be considered in water supply planning because construction of almost any type of water project could impact wetlands, either through the loss of wetlands or the change in wetland habitat. Loss of a stream and adjacent wetland areas is not offset by the creation of a reservoir because the habitat is different.

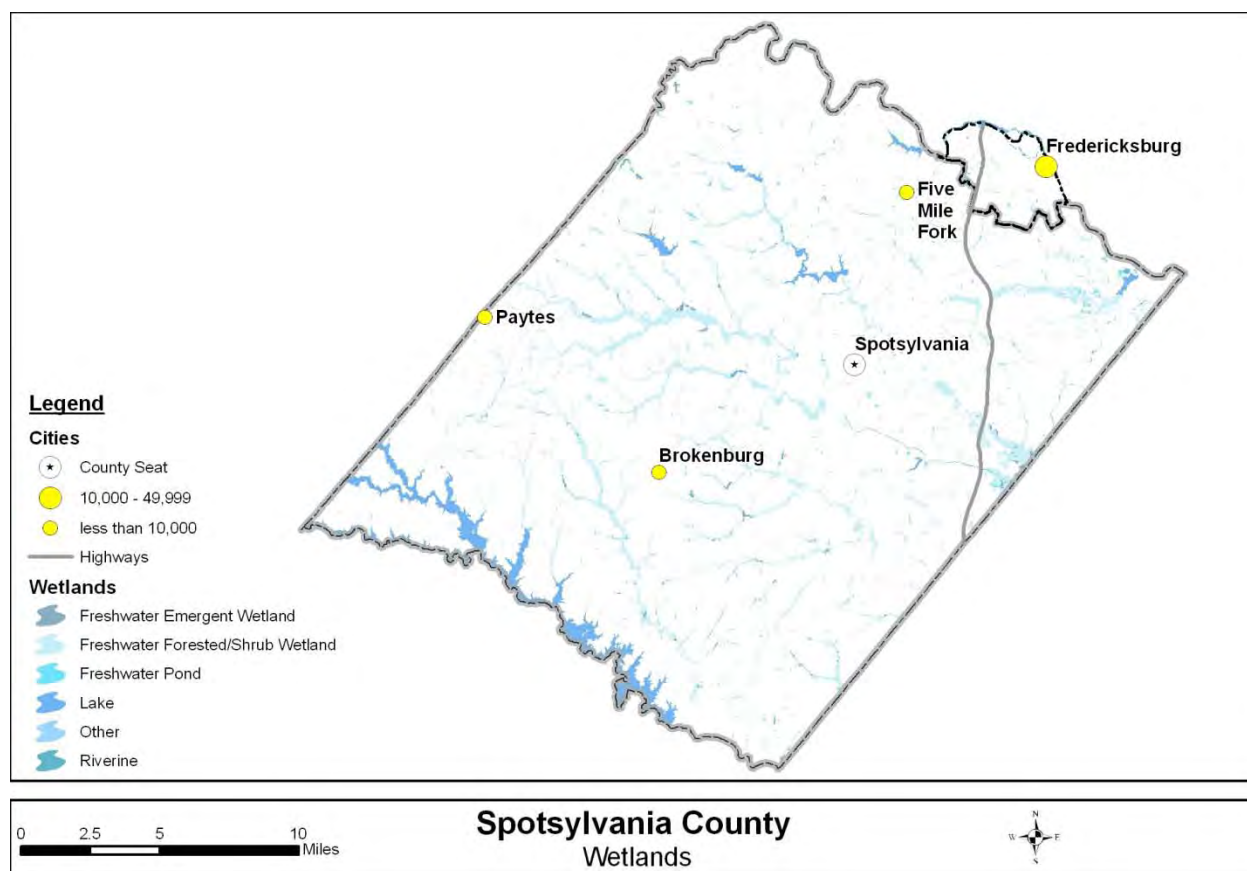


Figure 4-10: Wetlands

The definition of a jurisdictional wetland, according to the U.S. Environmental Protection Agency (EPA) and the U.S. Army Corps of Engineers, is “those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.” The U. S. Department of Agriculture Natural Resources Conservation

¹³ NWI accessed from <http://www.fws.gov/wetlands/Data/DataDownload.html>, on 03/01/2010.

Service (NRCS), and the U. S. Fish and Wildlife Service (FWS) define wetlands somewhat differently, but all four agencies include three basic elements – hydrology, soils and vegetation – for identifying wetlands.

The NWI provides information on the status, extent, characteristics and functions of wetlands throughout the United States and is a starting point for consideration of wetlands in water supply planning. However, NWI is not a comprehensive list of all the wetlands in the study area; therefore, on-site determinations of wetlands would be required during a detailed alternative analysis in development of any water resources. This analysis should follow the three-parameter method described in the Corps of Engineers Wetlands Delineation Manual (Environmental Laboratory 1987), which is the legally accepted system for identifying wetlands. The method requires positive evidence of three criteria – hydrophytic vegetation, hydric soils and wetland hydrology – before an area can be termed a wetland. Areas generally must have all three criteria to be designated as wetlands.

The strategy to always use when planning a project that has the potential to impact wetlands is to Avoid, Minimize, and Mitigate; always in that order. This means that the first step is to Avoid any jurisdictional wetlands, if at all possible. The second step is to Minimize the impacts to jurisdictional wetlands that cannot be avoided. The third and last step is to Mitigate the jurisdictional losses that cannot be avoided or minimized.

4.10 Riparian Buffers and Conservation Easements

Figure 4-11 shows City, Local, State and National Park Service Land and areas for which conservation easements have been recorded for Spotsylvania County and City of Fredericksburg¹⁴. This map also shows areas designated as Resource Protection Areas in Spotsylvania County and Riparian Easements as provided by the County and City, respectively. Development of water supplies on National Park Service Land should not be considered. It may be possible to develop of water supplies on City, Local, and State Park Service Land, lands for which conservation easements have been recorded, or on protected lands depending on the wording of the conservation easements. Primary consideration for water resource development

¹⁴ Data from http://www.dcr.virginia.gov/natural_heritage/cldownload.shtml. Accessed 08/12/2010.

should be given to areas of the county not tied up by National Park Service Land or in conservation easements.

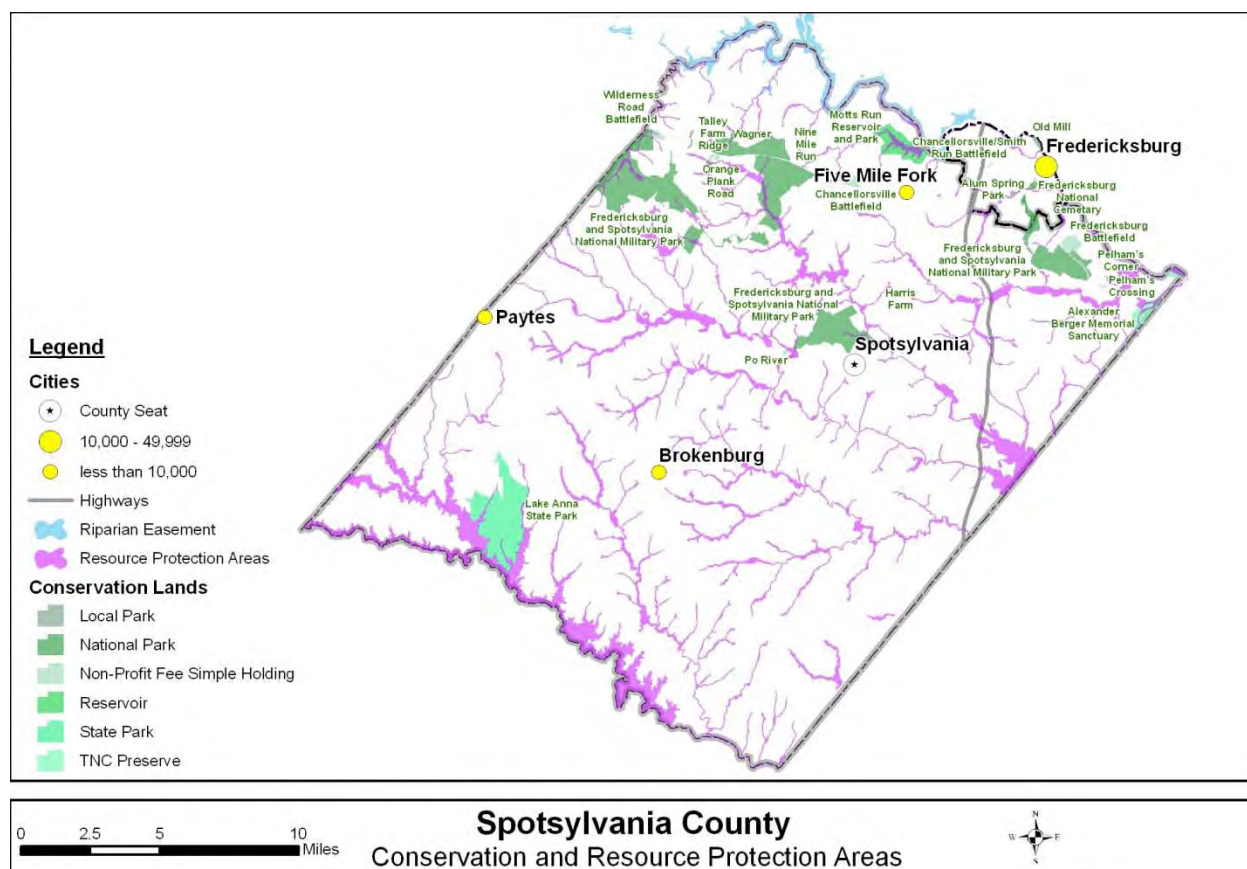


Figure 4-11: Conservation and Resource Protection Areas

Figure 4-12 shows riparian buffers along water bodies throughout Spotsylvania County. This map was generated by the Virginia Department of Forestry based on a GIS data layer compiled using an automated buffer inventory algorithm that compared the USGS National Land Cover Dataset and USGS 1:100k National Hydrography Dataset¹⁵. Riparian buffers perform important ecological functions including providing habitat and enhancing stream water quality, therefore development in and disturbance of these areas should be avoided. However, given the nature of water supply facilities it may be impossible to completely avoid riparian areas, in such cases disturbance should be minimized and special attention should be given to appropriate stormwater management practices.

¹⁵ Data from <http://www.dof.virginia.gov/regEast/spo-wq-rfb.shtml>, accessed 08/03/2010.

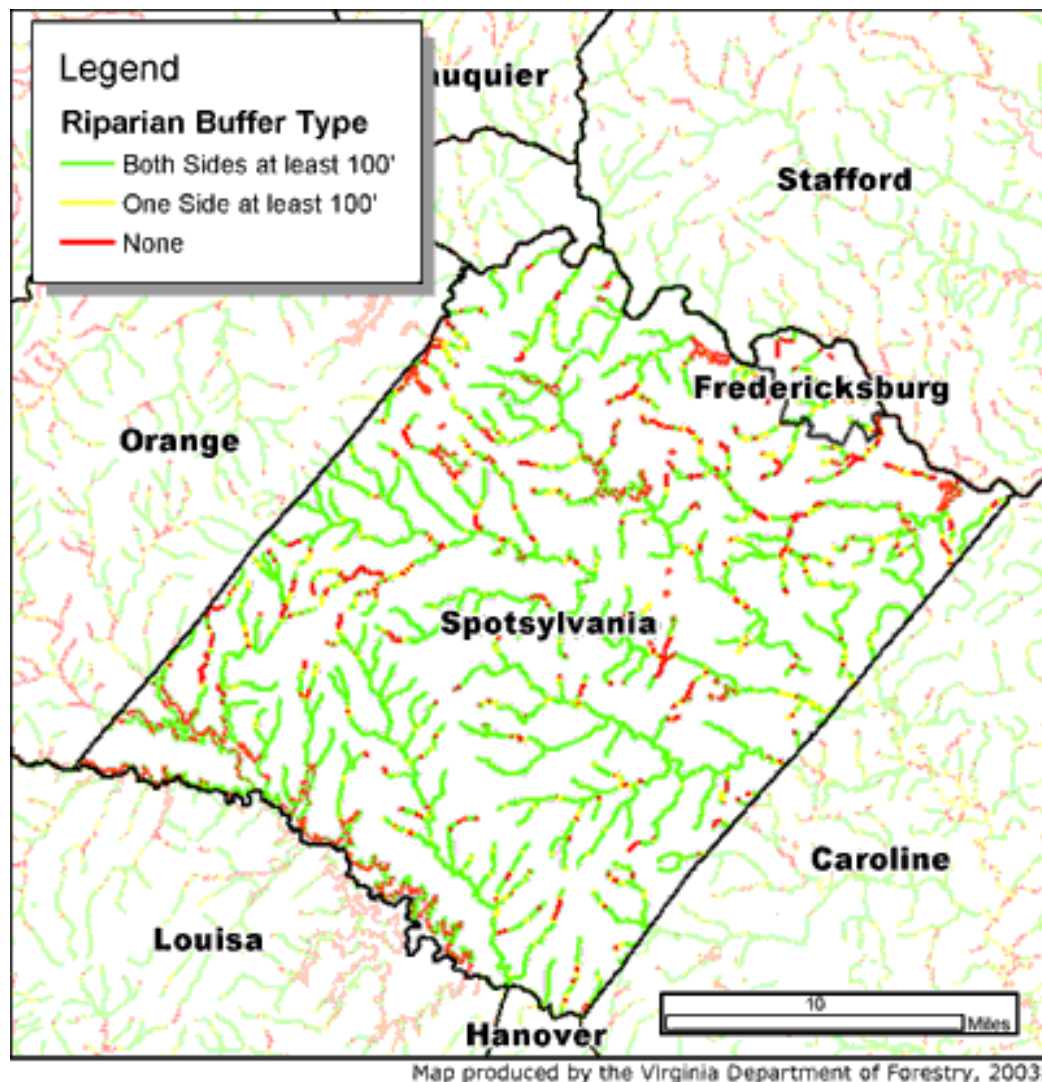


Figure 4-12: Riparian Buffers (VA Department of Forestry, 2003)

4.11 Land Use

Land Cover for Spotsylvania County and City of Fredericksburg is shown in Figure 4-13¹⁶. The County and the City combined consist of 423 square miles of land. The landscape is dominated by forested and agricultural lands comprising 63% and 24% of the study area, respectively. Only 5.3% of the study area is developed, which includes land cover categories of developed open space and low medium and high density developed lands. This percentage is a conservative representation of the extent of impervious area in the entire study area as not all developed land is impervious. However, the percent impervious would vary across the study area if calculated on a watershed basis, with the Lower Rappahannock watershed having the majority of developed

¹⁶ Data from <http://seamless.usgs.gov/>, accessed 08/03/2010.

lands and hence the greatest impervious cover. Impervious cover of the upstream watershed area should be evaluated for individual water supply alternatives.

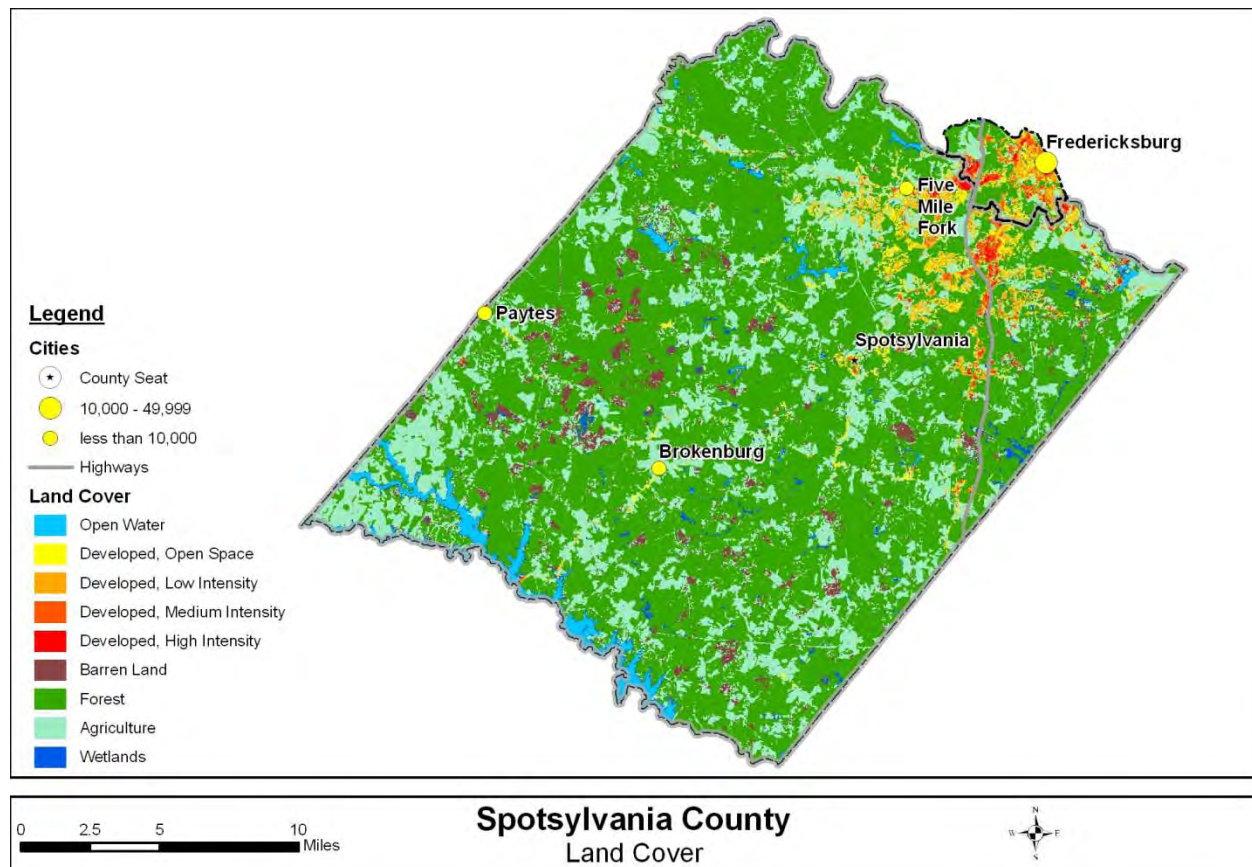


Figure 4-13: Land Cover

Future land use for Spotsylvania County as provided by the County is presented in Figure 4-14. Qualitative comparison of the 2002 Land Cover to the future land use, suggests that there will be continued growth in the eastern portion of the county, specifically along the Interstate-95 corridor. Future land use should be taken into consideration in the evaluation of water supply alternatives in terms of both the increased demand resulting from continued development and the pollution potential posed by conversion of agricultural and forested lands to developed lands.

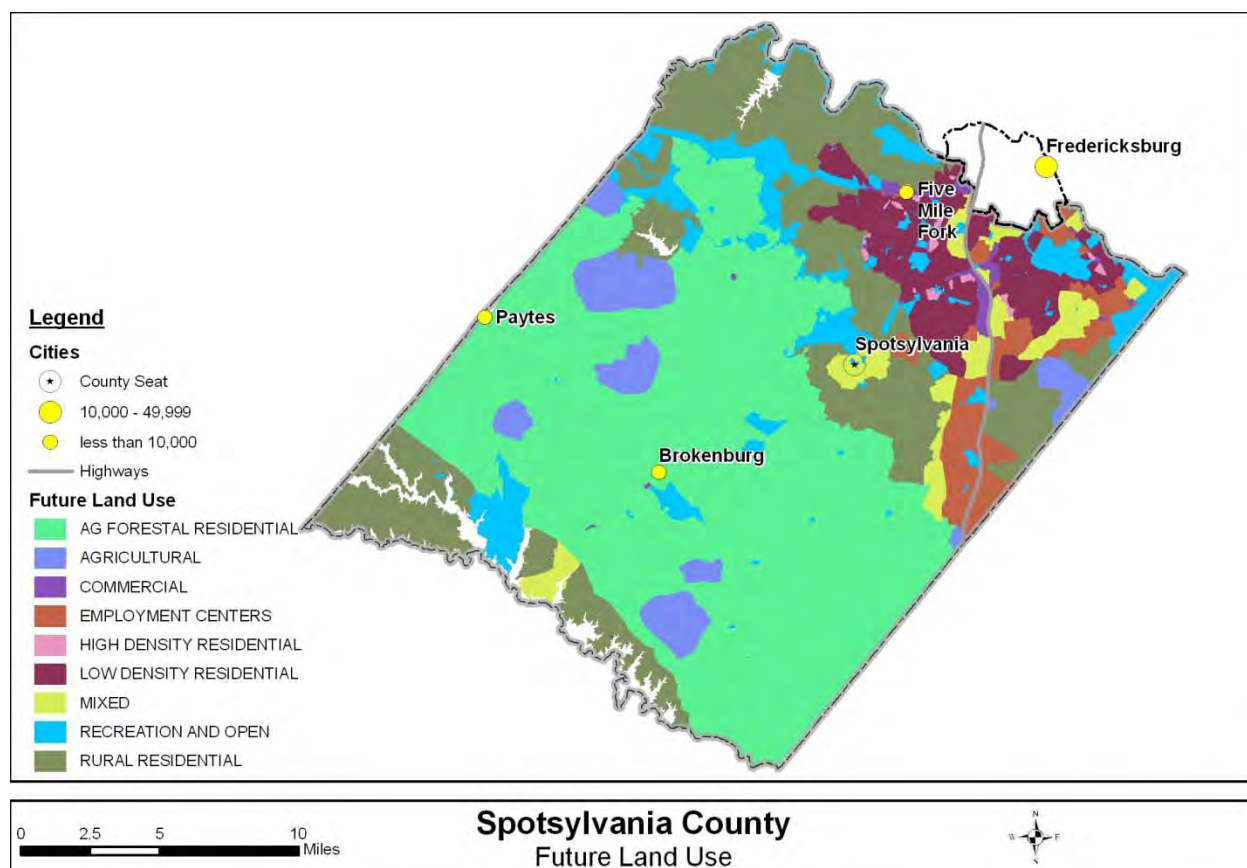


Figure 4-14: Future Land Use

4.12 The Presence of Impaired Streams and the Type of Impairment

Impaired waterways in Spotsylvania County and City of Fredericksburg are shown in Figure 4-15. The type of impairment for each water body is listed in Table 4-3. GIS data from the Virginia DEQ Water Quality Assessment website was used to create Figure 4-15¹⁷. Information used to populate Table 4-3 was retrieved from the DEQ's 2008 Impaired Waters Fact Sheet¹⁸.

Impairment information should be considered in the development of water supply alternatives, but should not necessarily be considered grounds for elimination of an alternative unless the water body is listed as impaired for public drinking water supply. Water bodies in the study area are listed as being impaired for recreation, fish consumption, and aquatic life. None are impaired for public drinking water supply.

¹⁷ Obtained from the Virginia DEQ Water Quality Assessment website (<http://www.deq.virginia.gov/wqa/ir2008.html>, accessed 08/09/2010).

¹⁸ Obtained from <http://gisweb.deq.virginia.gov/FactSheets2008/Choose.aspx>, accessed 08/03/2010.

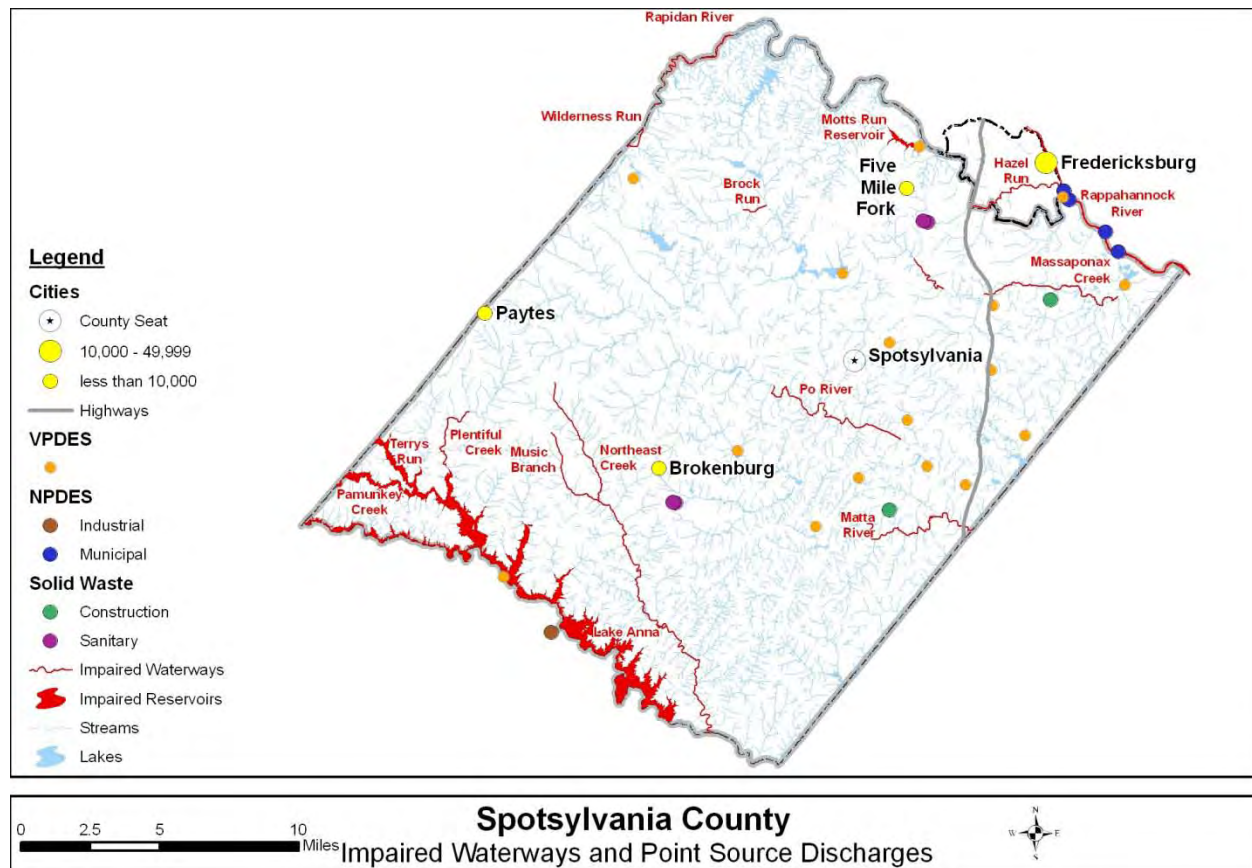


Figure 4-15: Impaired Waterways and Point Source Discharges

Table 4-3: Impaired Waters		
Water Body	Segment	Type of Impairment
Wilderness Run	Confluence of North and South Wilderness Run to confluence with Rapidan River	Recreation
Rapidan River	Confluence with Wilderness Run to confluence with Middle Run	Recreation
Rappahannock River	Rt. 1 to confluence with Deep Run	Fish Consumption Recreation Aquatic Life
	Confluence with Deep Run to confluence with Massaponax Creek	
	Confluence with Massaponax Creek to unnamed tributary	
Hazel Run	Rt. 95 crossing to confluence with Rappahannock River	Fish Consumption Recreation Aquatic Life
Massaponax Creek	Approximately 1.1 RMs downstream from Rt. 673 to approximately 0.25 RM upstream of Rt. 639	Recreation
	Just upstream of Rt. 1 to approximately 0.25 RM upstream of Ruffins Pond	Recreation Aquatic life
Motts Run Reservoir	Upper end of Reservoir to RM 0.8	Fish Consumption Aquatic life
	RM 0.8 to lake discharge	
Po River	Confluence with Gladly Run to RM 6.69	Recreation
Matta River	Approximately 0.5 RMs upstream of the Rt. 632 bridge to confluence with the Poni River	Recreation Aquatic Life
	Confluence with the Ta River to approximately 0.5 RMs upstream of Rt. 646	Aquatic Life
Brock Run	Confluence with Wash Branch to confluence with Ni River	Recreation
Northeast Creek	Headwaters to approximately 2.28 RMs downstream of Rt. 208	Aquatic Life
	RM 9.39 to approximately 0.67 miles upstream from Rt. 622	Recreation Aquatic Life
	Approximately 0.67 miles upstream from Rt 622 to confluence with unnamed tributary	Recreation Aquatic Life
	Confluence with unnamed tributary to confluence with the North Anna River	Recreation
Music Creek	Headwaters to confluence with Northeast Creek	Recreation
Plentiful Creek	Upstream from Rt. 601 bridge to confluence with Lake Anna	Recreation
Lake Anna	Upper – upper boundary to Rt. 208 bridge	Fish Consumption
	Middle - Rt. 208 Bridge to northern end of Rt. 609 bridge	
	Lower - northern end of Rt. 609 bridge to the dam	
	Plentiful Creek Arm	
	Pamunkey Creek Arm to confluence with North Anna River	
	Terrys Run Arm	
Terrys Run	Headwaters to confluence with Horsepen Branch	Fish Consumption

4.13 The Location of Point Source Discharges

Locations of point discharge in Spotsylvania County and City of Fredericksburg are also shown in Figure 4-15¹⁹. There are currently twenty two (22) combined Virginia Pollution Discharge Elimination System (VPDES) and National Pollution Discharge Elimination System (NPDES) permits administered by the Virginia Department of Environmental Quality in or adjacent to Spotsylvania County and City of Fredericksburg. Point source discharges present a threat to water quality and should be considered and accounted for in the development and evaluations of water supply alternatives. Water supplies that are influenced by point source discharges may require higher levels of treatment (greater chemical addition, advanced treatment processes) to meet drinking water quality standards.

4.14 Potential Threats to the Existing Water Quantity and Quality

The Source Water Assessments conducted by the Virginia Department of Health in 2002 and 2003 rank all of the public water supplies (surface and groundwater) in Spotsylvania County as being highly susceptible to degradation. The Assessment further identified future land development in source water protection areas as the predominant threat to water supplies.

The future land use plan for the County, as presented in Figure 4-14, calls for continued growth in the eastern portion of the county, specifically along the Interstate-95 corridor. Such planned development must be taken into consideration in the evaluation of water supply alternatives in terms of the pollution potential posed by conversion of existing agricultural and forested lands to developed lands. A good portion of these lands are planned for employment centers and mixed use which may involve large parking lots and associated threats from stormwater runoff if not properly managed. The areas surrounding the Motts Run and Hunting Run reservoirs are identified as being primarily forested land in the 2002 NLCD as shown on Figure 4-13. Both areas are identified as rural/residential in the County's Future Land Use Plan. A potential future threat to these supplies that might result with even minimal residential development is that posed by septic systems, which if not operated properly can release untreated waste that may ultimately discharge to the water supply. Additionally, the counties surrounding Spotsylvania are also experiencing rapid growth. Planned development along the Rappahannock River in Stafford

¹⁹ Data obtained from (<http://gisweb.deq.state.va.us/> accessed 08/05/2010 and <http://www.deq.virginia.gov/wqa/ir2008.html>, accessed 08/09/2010).

County, the Rapidan River in Culpeper County or along Lake Anna in Louisa County should be considered in evaluating water supply alternatives.

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5.0 PROJECTED WATER DEMAND

This section contains an assessment of projected water demands in accordance with the requirements of 9VAC 25-780-100.

5.1 Historical and Future Population Growth

Since historical population analysis provides a foundation for estimating future population growth and water demand, population data was examined.

The County has experienced rapid population growth since the 1960's. Although Spotsylvania County population growth has slowed somewhat this past decade to 35%, on average Spotsylvania has grown 57% per decade as shown in Table 5-1. This growth is principally due to the County's location along Interstate 95 midway between Washington, D.C. and Richmond as well as the high quality of life available²⁰. City of Fredericksburg has also grown over this time, averaging 11% growth per decade.

Table 5-1: Historical Population				
Year	Spotsylvania County	Decennial Growth	City of Fredericksburg	Decennial Growth
1960	13,819		13,639	
1970	16,424	19%	14,450	6%
1980	34,435	110%	15,322	6%
1990	57,403	67%	19,027	24%
2000	90,395	57%	19,279	1%
2010	121,791 ²¹	35%	22,239 ²²	17%
	Average County Growth per Decade	57%	Average City Growth per Decade	11%

Using this historical population data as the foundation, three different methodologies were compared to project the future population for the county. These included:

²⁰ [Spotsylvania County Comprehensive Plan, adopted November 12, 2008.](#)

²¹ Provided by Spotsylvania County Planning. Based on U.S. Census Data for 2009 and County building permit data.

²² Retrieved from [Weldon Cooper Center for Public Service](#), Demographics & Workforce Group

1. Using Virginia Employment Commission Projections through 2030 and projecting this data linearly through 2060
2. Projecting population based on the County's anticipated growth rate of 2% per year²³
3. Projecting population linearly based on last 10 years of data

The City of Fredericksburg was projected linearly from the population projection data from the Weldon Cooper Center for Public Service, Demographics & Workforce Group.

The results of these projections are shown in Figure 5-1. After reviewing the results with the County, the population projection based on a 2% growth per year was considered most realistic. Based on this growth rate, Spotsylvania County population is projected to more than double in 2060 to 303,055. The City of Fredericksburg's projected population in 2060 is 31,122.

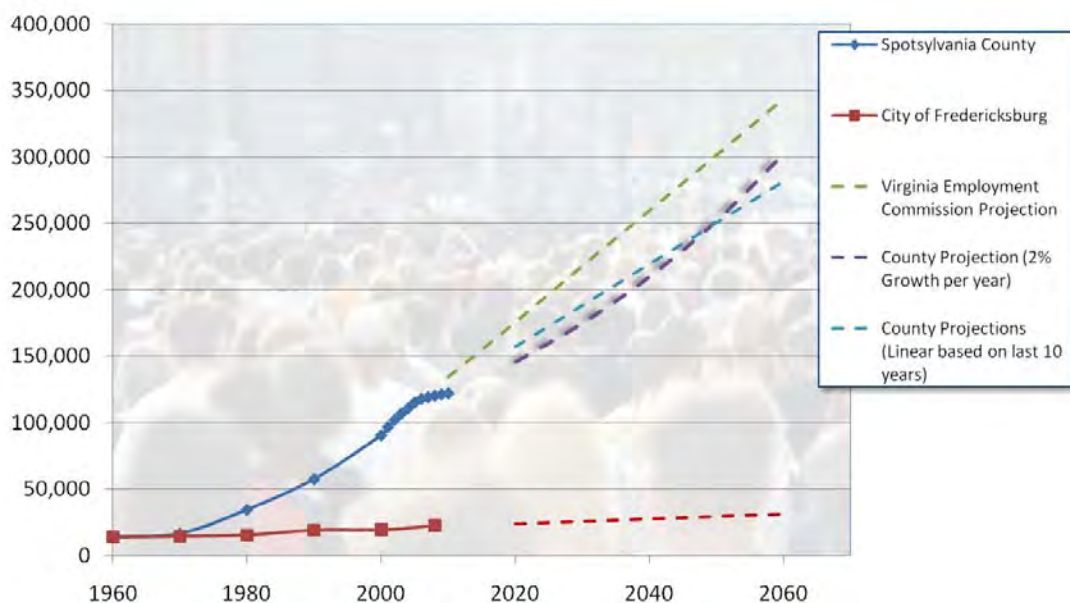


Figure 5-1: Spotsylvania County and City of Fredericksburg Population Projections

For consistency, a 2% per year growth to was applied to the service area population for the County, City, self-supplied and private water systems populations. It is assumed that the growth in self supplied and private water systems will be the same as the percent change in population

²³ Spotsylvania County Comprehensive Plan, adopted November 12, 2008, page 6

for the jurisdiction. The breakdown of the demand projections are shown in Table 5-2 and Figure 5-2.

Table 5-2: Population Projections Breakdown					
	City of Fredericksburg	Self-Supplied Users	Private Water Systems	Spotsylvania County Service Area	Spotsylvania County Total
2020	25,116	42,962	2,379	75,692	146,149
2030	28,518	51,554	2,379	92,928	175,379
2040	31,570	61,865	2,379	114,641	210,455
2050	34,710	74,238	2,379	141,219	252,546
2060	37,849	89,086	2,379	173,741	303,055

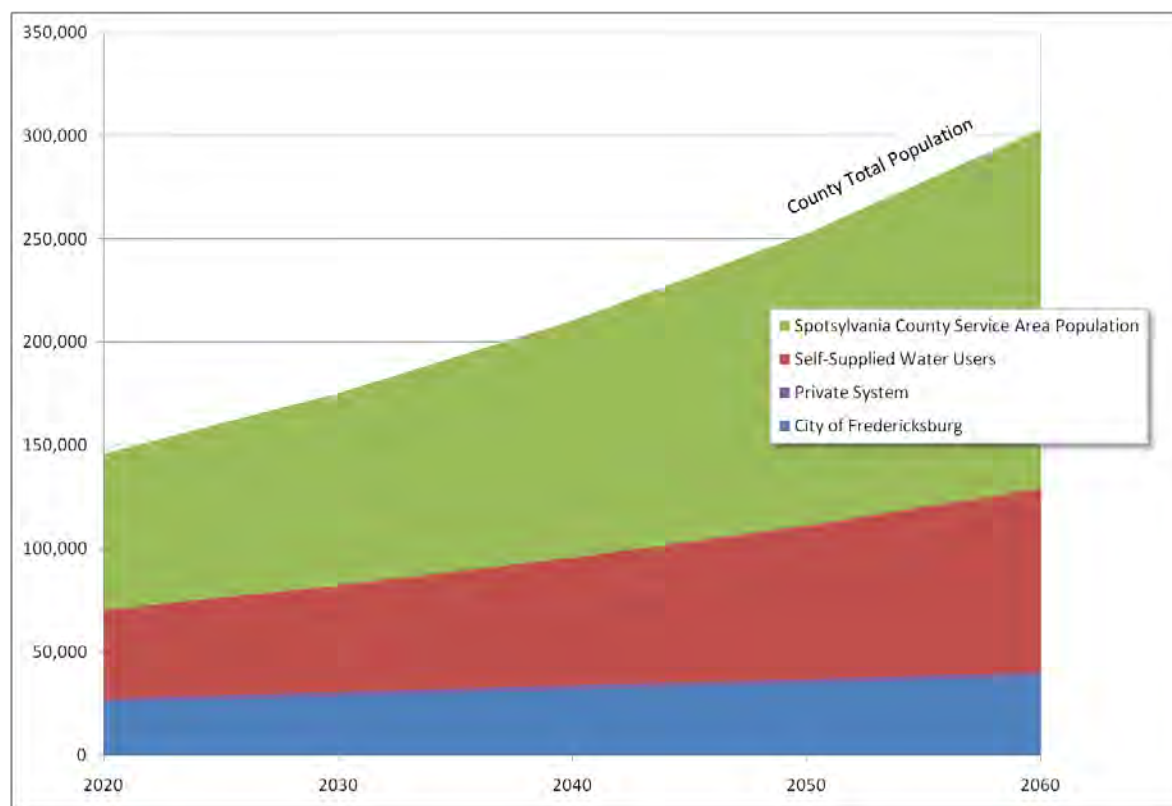


Figure 5-2: Spotsylvania County Population Projection Breakdown

5.2 Projected Water Demand

Projecting water demand is the process of making predictions about future water use based on historical water use. Different forecast horizons often require different types of forecast models, and different levels of reliability. The requirements for this plan require a long-term forecast for the planning area 50 years into the future with water use calculated at the beginning of each decade (2010, 2020, 2030, etc.).

Long-term water forecasts allow water system time to develop new capital intensive facilities such as water treatment plants or reservoirs, as required. Major influences on water demand can be population, employment, weather, and conservation programs. While a wide range of methods can be used in forecasting the availability of data is often the primary constraint on developing forecasting models²⁴.

5.2.1 Municipal Community Water Systems

The per capita water use was examined for the Municipal Community Water Systems for the most recent 2009 year and years 2007 and 2003 which represent dry and wet years, respectively. This allowed and assured that climatic conditions were considered in long term demand projects. For the Spotsylvania County water service area, gallons per capita were 111, 113.7, 127, for 2009, 2007, and 2003, respectively. Since the per capita use did not vary significantly, an average per capita from the period of record was used to project the water demands as shown in Table 5-3 and Figure 5-3.

Table 5-3: Public Community Water Demand Projection (MGD)						
Water System Name	Current (2009)	2020	2030	2040	2050	2060
Spotsylvania County	6.8	8.4	10.3	12.6	15.5	19.2
City of Fredericksburg	2.5	3.2	3.63	4.0	4.4	4.8

²⁴ Billings, R. Bruce., and Clive Vaughan. Jones. *Forecasting Urban Water Demand*. Denver, CO: American Water Works Association, 2008. Print.

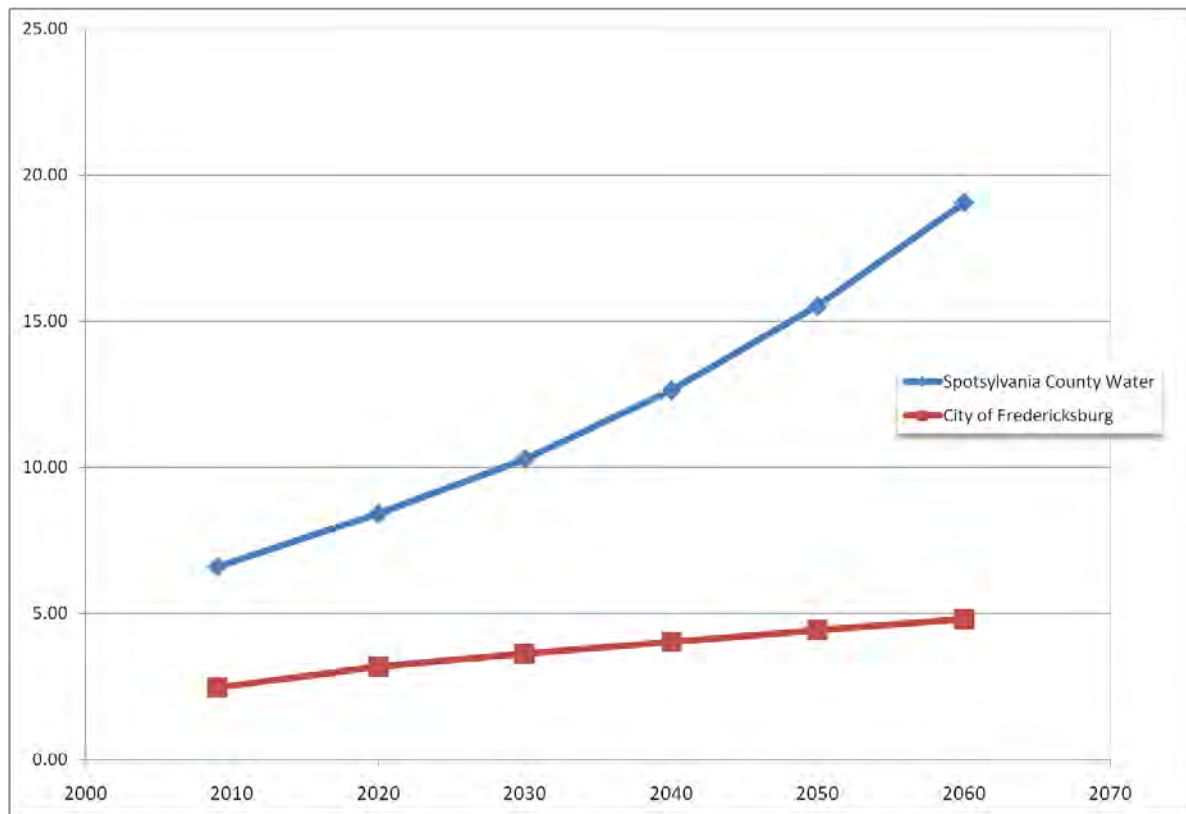


Figure 5-3: Municipal Community Water System Demand Projections

Disaggregated demands were projected assuming that the percentage contribution of each use category remained constant with the 2009 breakdown, as previously shown in Table 3-4. Spotsylvania County and City of Fredericksburg disaggregated demand projections are shown in Figure 5-4 and Figure 5-5, respectively.

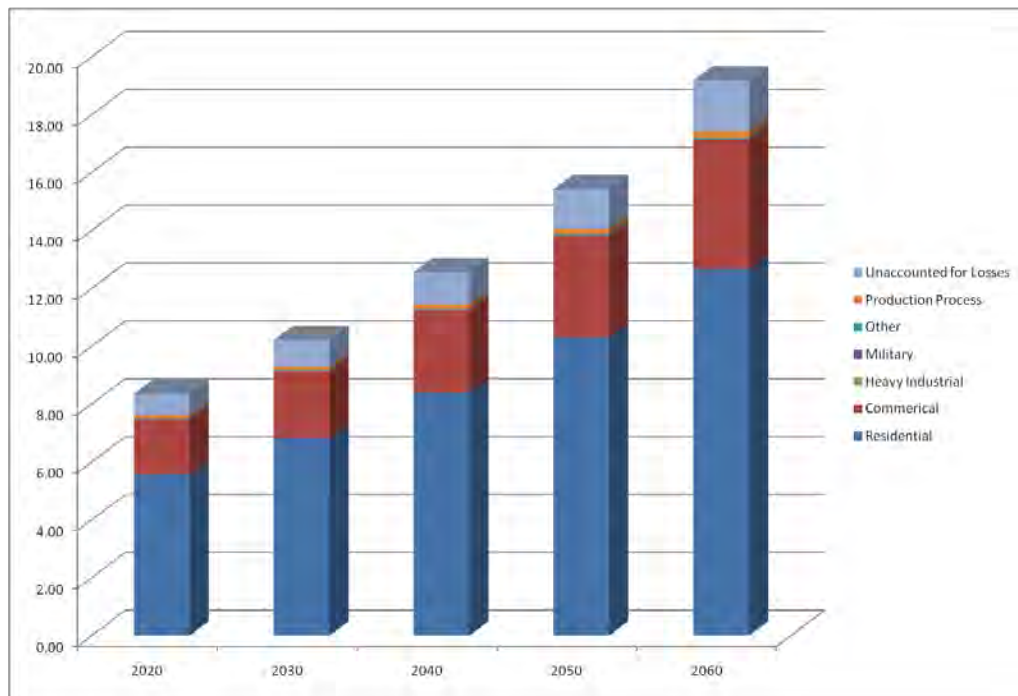


Figure 5-4: Spotsylvania County Water Disaggregated Water Use Projection

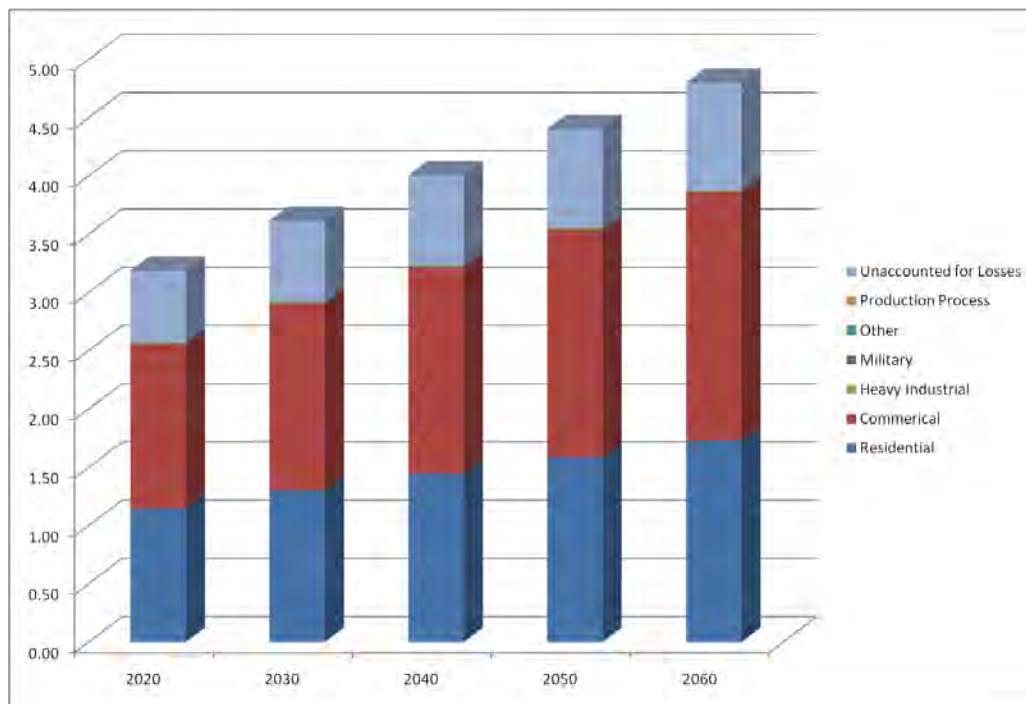


Figure 5-5: City of Fredericksburg Water Disaggregated Water Use Projection

5.2.2 Private Community Water Systems

Due to the limited value of projecting the individual demands of each private community water system, the following private water systems were lumped together:

- Glenwood Mobile Home Park (PWSID 6177105);
- Lake Wilderness, Sec 1-11 (PWSID 6177251);
- Lake Wilderness, Sec 12-16 (PWSID 6177252); and
- Lynn Castle Park (PWSID 6177266).

Private Community water systems in the region are not expected to increase in the future and in many areas of the region will likely decrease as growth occurs. To be conservative these projections were maintained at the current rate of .2 MGD throughout the planning period.

5-3: **Private Community Water Systems Demand Projection**

Self-Supplied, Non-Agricultural Using Greater Than 300,000 Gallons per Month

In order to project the future demands for self-supplied, non-agricultural users the annual average percent change in population was applied to the total demand from each of these users as shown in Table 5-4 and Figure 5-6.

Table 5-4: Self-Supplied, Non Agricultural Demand Projection (MGD)						
Type	Current (2009)	2020	2030	2040	2050	2060
Groundwater	0.1	0.12	0.15	0.18	0.21	0.25
Surface Water	0.04	0.05	0.06	0.07	0.08	0.10

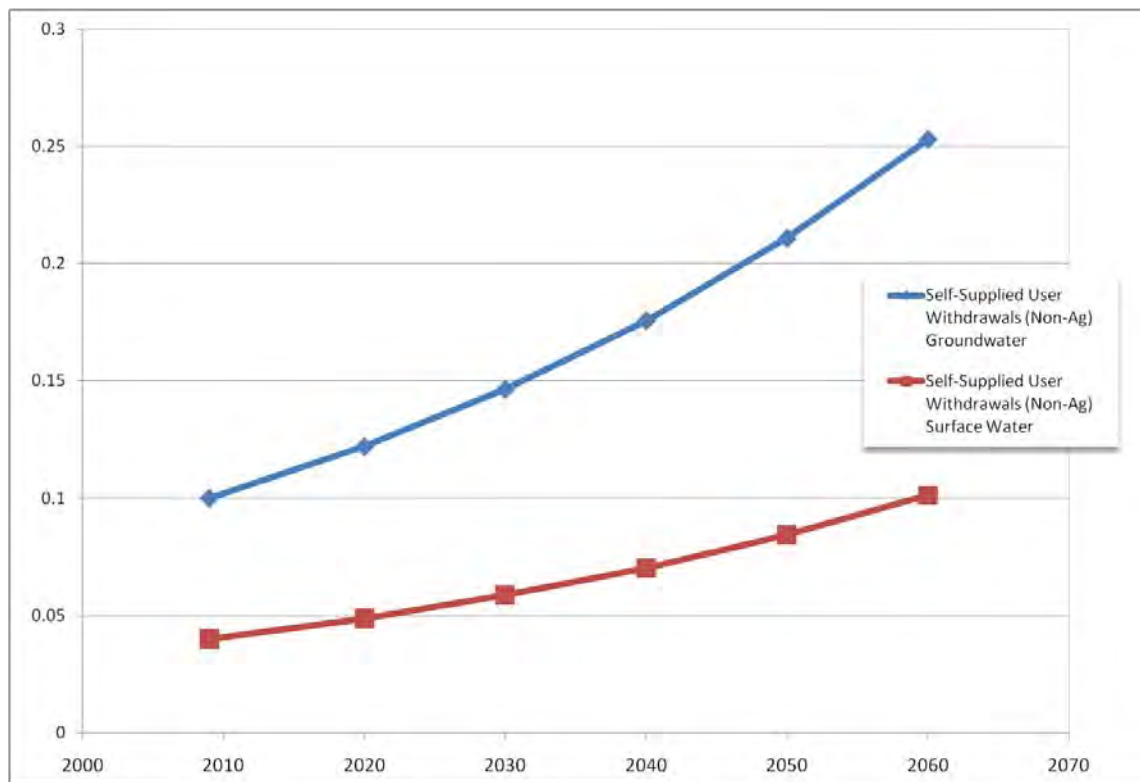


Figure 5-6: Self-Supplied Demand Projection

Self –Supplied, Agricultural Users Using Greater Than 300,000 Gallons of Water Per Month

Information on self-supplied, agricultural users using greater than 300,000 gallons of water per month was very limited or unavailable. Agricultural information for each county was collected from the USDA NASS 2002 Census of Agriculture. General information on livestock (e.g., number of head of cattle) and crops (e.g., type of crop planted) was available and was used to make a general estimate of water used by self-supplied, agricultural users in the region.

Agriculture in the region is not expected to increase in the future and in many areas of the region will likely decrease as growth occurs. To be conservative agricultural projections were maintained at the current rate of .12 MGD throughout the planning period.

Self-Supplied, Residential Users Using Less Than 300,000 Gallons Per Month

Self-Supplied Residential Users comprised approximately 25% of the total demand in the planning area in 2009. Most of these users are located in the more rural areas of the county, which are likely to experience growth in the coming decades. The per capita use for self-supplied

residential users is assumed to mirror the use calculated for the municipal community water systems. Thus, demand projection were calculated assuming a 111 gallon per capita per day use rate, as shown in Table 5-5 and Figure 5-7.

Table 5-5: Self-Supplied Demand Projection (MGD)					
Water System Name	2020	2030	2040	2050	2060
Spotsylvania County	4.3	5.16	6.2	7.4	8.9

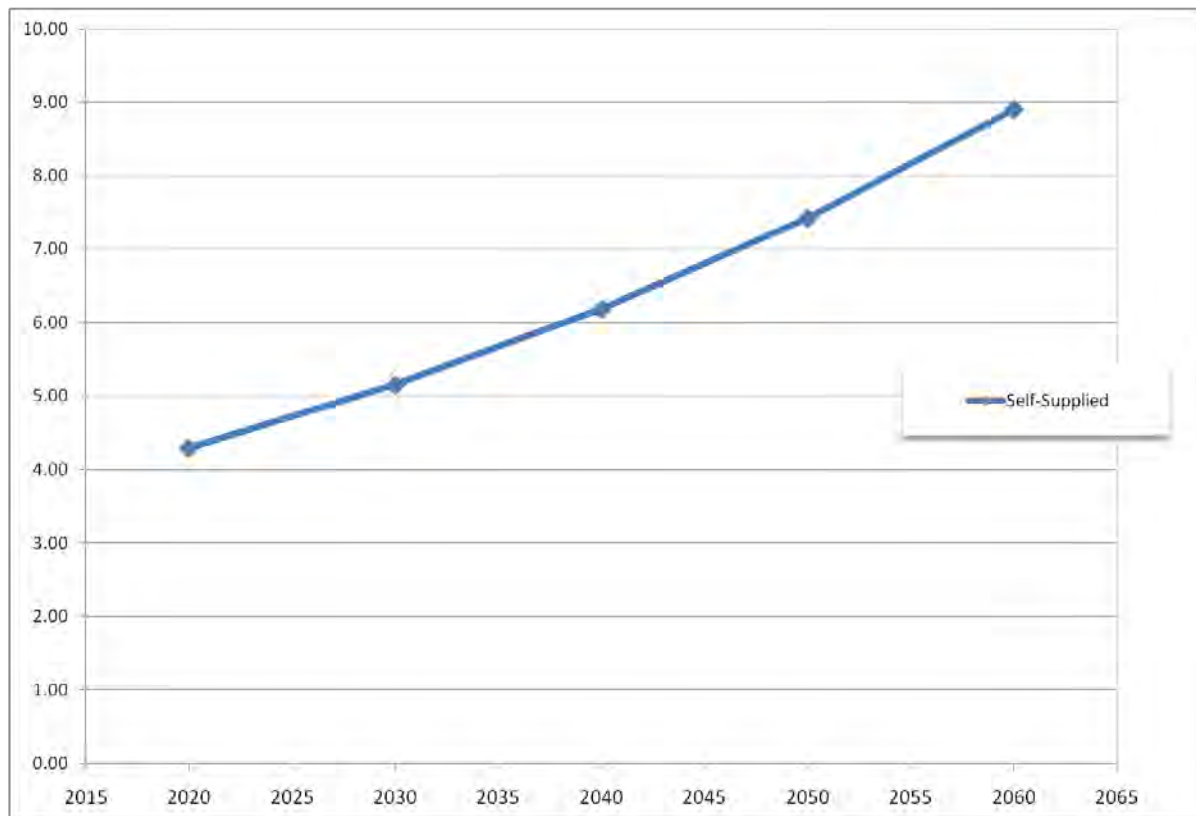


Figure 5-7 Self-Supplied Demand Projection

6.0 WATER DEMAND MANAGEMENT (9 VAC 25-780-110)

In accordance with the requirements of 9 VAC 25-780-110A, the plan needs to address conservation as a part of overall water demand management in accordance with the following requirements:

- i) Include information that describes practices for more efficient use of water that are used within the locality. The type of measure to be described may include the adoption and enforcement of the Virginia Uniform Statewide Building Code sections that limit maximum flow of water closets, urinals, and appliances; use of lower-water use landscaping; and increases in irrigation efficiency.
- ii) Include information describing the water conservation measures used within the planning area to conserve water through the reduction of use. The types of measures to be described may include technical, educational, and financial programs.
- iii) Include information that describes, within the locality, the practices to address water loss in the maintenance of water systems to reduce unaccounted for water loss. The types of items to be described may include, but are not limited to, leak detection and repair and old distribution line replacement.

The following sections describe water demand management actions in accordance with the requirements of 9VAC 25-780-110.

As a region's population grows and water demands increase, it becomes increasingly important to manage not only the water supply and treatment, but also the demand on an ongoing basis. One tool that water utilities use to manage demand is to develop a comprehensive water conservation program. Water conservation is broadly defined as the beneficial reduction in water use, waste, and loss. The ultimate goal of water conservation is not to prevent water use, but to maximize efficiency and the benefit from each gallon used. Thus, efficient water use is often considered the minimal amount of water that is technically and economically feasible to achieve an intended function.

The benefits of water conservation not only assist with protecting water supply during drought, but on-going water conservation efforts may reduce demand sufficiently to delay the need for new supply development and infrastructure expansion for both water and wastewater treatment, as well as reduce the need for additional short-term and long-term storage capacity by reducing high peak demands.

Recognizing the importance of demand management and conservation as components of long term water supply planning, Spotsylvania County is in the process of developing and implementing a Water Conservation Program. In 2010 the County contracted with Black & Veatch for the development of a Water Conservation Plan. Through this process the County evaluated and prioritized water conservation best management practices for implementation.

The County is currently working on adopting a suite of water conservation management practices, which represents a significant expansion of their water conservation program and is focused on outdoor irrigation and other outdoor water uses. Reducing indoor demand through improved technology and behavior change will improve system reliability and resilience. Reducing outdoor demand through improved irrigation efficiently improves reliability during summer months when demand peaks, providing additional water availability for storage and environmental flows. Most importantly, Spotsylvania County will assure continued abundant water supply and high quality service to customers in case of future drought or unforeseen shortages.

6.1 Water Use Efficiency Measures

Water use efficiency measures or initiatives are designed to reduce the amount of water wasted in various applications.

Spotsylvania County has adopted and actively enforces the Virginia Uniform Statewide Building Code (USBC) standards for maximum flow of various fixtures and appliances. The County adopted these Codes, prior to much of the development that has occurred in the past two decades and thus reducing the demand resulting from the development.

The Virginia USBC is a state regulation promulgated by the Virginia Board of Housing and Community Development, a Governor-appointed board, for the purpose of establishing minimum regulations to govern the construction and maintenance of buildings and structures.

The provisions of the USBC are based on nationally recognized model building and fire codes published by the International Code Council, Inc. The 2003 editions of the International Codes are incorporated by reference into this version of the USBC.

Enforcement of the USBC is the responsibility of the Spotsylvania County building inspections department. While the County does not have any additional requirements above those incorporated into the USBC, the National Energy Policy Act of 1992 which mandated the introduction of 1.6 gallon-per-flush toilets and reduced maximum allowable flow rates for showerheads in the United States has led to more efficient water use in the County.

Looking forward, water system policy initiatives designed to increase water use efficiency ranked high in the County's review and prioritization of future conservation measures. Of the measures considered "New Development Requirements (in-door and out-door)" ranked second only to "Regional integration of water supply and conservation planning. "Irrigation system rebates" for residential and commercial/industrial customers was also viewed as a priority measure.

The County is also interested in developing "Voluntary Certification Programs". These programs would provide incentives for businesses to conserve water through the use of water efficient equipment and practices. Businesses that might be targeted include but are not limited to: car washes, power washers, restaurants, and landscapers/irrigation professionals. The incentives might range from reduced fees or rebates, to recognition in the form of a certificate or placard, to promotion of the certified businesses.

6.2 Water Use Reduction Measures

Spotsylvania County realizes strategic pricing of water can also be helpful in achieving water conservation. Some of the useful options for pricing are tiered rate structure, time of day pricing, water surcharges, and rebates for water conservation. Spotsylvania has adopted a tiered rate structure which provides direct incentives to reduce water demand and save on water bills. In the past, many utilities, like Spotsylvania, had declining block structure, where a user actually pays less per gallon if a user consumes more, to a flat rate structure, where all users pay the same cost per gallon of water no matter how much a user consumes.

In January 2010, the County revised their water and sewer ordinance to include a tiered fee structure in which rates for various user categories increase with volume of water used, and rates for Tier 2 and above are to have additional incremental increases over the next two and one half years. The rate structure also stipulates greater fees for irrigation water than for indoor water use. Finally, the ordinance contains a new section “Sec. 22-140 Green Initiative and Conservation Program”, which allows for future adoption of rebates, rate adjustments or other initiatives to reduce peak demands and/or overall consumption.

The County provides education and outreach to children and home owners on conservation through in-classroom activities and lesson plans and web-based information.

Education and outreach initiatives to promote conservation and reduce water use comprised five of the top ten priority conservation measures for future implementation. The County sees value in educating the public on conservation and best practices to reduce water use through activities such as demonstration projects, advertising campaigns, educational programs, and dissemination of outreach materials. Based on the prioritization of demand management practices, it appears likely that education and outreach will be a significant component of the Water Conservation Program.

6.3 Water Loss Reduction Measures

Water loss occurs in two ways:

1. Actual water lost from the distribution system through leaks, tank overflows, flushing of water lines, and fire suppression. These are called real losses.
2. Water that reaches a customer or intended use but that is not properly measured or tabulated. These are referred to as apparent losses.

Real losses contribute to demand, directly requiring water suppliers to supply, treat, and transport greater volumes of water than their customer demand requires. Leakage is the most common form of real losses for water suppliers. Apparent losses do not result in the physical losses as that of real losses, but exert a significant financial effect on water supplies. These losses represent service rendered without payment. Apparent losses of water occur as errors in water flow measurement, errors in water accounting, and/or unauthorized usage.

Spotsylvania County has established a Distribution System Optimization Program made up of several divisions of the utility that work to reduce and monitor both real and apparent losses. This committee reviews work orders and distribution data and coordinates reduction efforts with the County's Capital Improvements Plan.

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7.0 DROUGHT RESPONSE AND CONTINGENCY PLANS (9 VAC 25-780-120)

This section includes a description of drought response and contingency plans in accordance with the requirements of 9VAC 25-780-120.

Drought is a normal, recurrent “natural” hazard that occurs in virtually all parts of the world. However, a lack of one universal definition of a drought, combined with the difficulty in determining when a drought begins and ends, has resulted in the slow development of drought preparedness and policy development. As population increases in many parts of the world, droughts will only exacerbate the competition for water resources.

The 2002 drought in the Commonwealth of Virginia resulted in stream flows reaching record lows and thousands of individual private wells failing. As a result of this drought, on December 13, 2002, the Governor of Virginia issued Executive Order Number 39, which required the Commonwealth’s Drought Coordinator to develop a formal Drought Assessment and Response Plan. A drought response Technical Advisory Committee chaired by the Virginia Department of Environmental Quality was formed to develop this plan.

Thirteen drought evaluation regions were established based on a consideration of river basins, climatic divisions, and other features. Spotsylvania County is in the Northern Piedmont Drought Evaluation Region. The Drought Assessment and Response Plan uses the following four indicators to evaluate the drought severity:

- Precipitation deficits
- Stream flows
- Groundwater levels
- Reservoir storage

The plan acknowledges that there exists a substantial amount of variability throughout the Commonwealth and, as such, one plan cannot be expected to represent the entire Commonwealth of Virginia. For example, water supply systems that rely on smaller streams and do not have storage may experience large impacts from a small drought, whereas water systems that rely on larger reservoirs may experience limited impacts from the same drought.

Due to the variability of drought conditions across the Commonwealth, local governments have the power to declare drought emergencies and implement conservation activities prior to the declaration of a drought emergency by the Governor of the Commonwealth of Virginia.

7.1 Purpose

A drought contingency plan is required as part of the Local and Regional Water Supply Planning Regulation, 9 VAC 25-780-120. The requirements state that the drought plan must do the following:

1. Address the unique characteristics of the water source that is being utilized and the nature of the beneficial use of water.
2. Contain, at a minimum, the following three graduated stages of response to the onset of drought conditions:
 - a. Drought watch,
 - b. Drought warning, and
 - c. Drought emergency.
3. Include references to local ordinances, if adopted, and procedures for the implementation and enforcement of drought response and contingency plans.

7.2 Existing Drought and Contingency Plans

Spotsylvania County and the City of Fredericksburg receive their public water supply from three sources; the Ni River Reservoir, and the Motts Run and Hunting Run reservoir system. There are also five smaller Community Water Systems which utilize surface water or ground water. Therefore, during drought conditions, the County should be responsive to potential shortages in each of the sources.

7.2.1 Spotsylvania County's Water Emergency Plan

The Spotsylvania County Water Emergency Plan is attached in Appendix A²⁵. The purpose of the plan, which has evolved over the last decade, is to reduce the use of public water and thereby preserve the water supply by implementing certain voluntary and mandatory water use

²⁵ (Ord. No. 22-3, 9-24-91; Ord. No. 22-20, 8-10-04; Ord. No. 22-23, 12-13-05)

restrictions. The ordinance authorizes the county administrator to declare a water emergency, to implement one of four levels of water use restrictions based on the extent of the water deficit, and to impose fines to those in violation of the ordinance.

The declaration of a water emergency and determination of appropriate restrictions is to be based upon the following:

- Water levels, available/usable storage on hand, draw down rates and the projected supply capability in source reservoirs in Spotsylvania County and other localities supplying water to the county;
- Supply capacity, rate of usage and projected supplies of wells in the water system and open stream sources available to the water system;
- System purification and pumping capacity;
- Daily water consumption and consumption projections of the system's customers;
- Prevailing and forecast weather conditions;
- Fire service requirements;
- Pipeline conditions including breakages, stoppages and leaks;
- Supplementary source data; and
- Estimates of minimum essential supplies to preserve public health and safety and such other data pertinent to the past, current and projected water demands.

The four levels of restrictions are summarized below:

1. Moderate but limited supplies – voluntary water conservation measures;
2. Very limited supplies – curtailment of less essential water uses;
3. Critically limited supplies – mandatory reductions imposed on each customer to achieve a specified percentage reduction or volume; and
4. Crucially limited supplies – mandatory restrictions allow use only for purposes that are absolutely essential to life, health and safety.

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8.0 STATEMENT OF NEED AND ALTERNATIVE ANALYSIS

As part of the Local and Regional Water Supply Planning Regulation 9 VAC 25-780-130, “a water plan shall determine the adequacy of existing water sources to meet the current and projected demand.” An evaluation of the existing water sources was presented in Section 3 and the evaluation of the projected demand was in Chapter 5.

The average day demands in 2060 are expected to reach 19.2 mgd, while the equivalent source capacity is 19.4 mgd. When compared to average day demands, Figure 8-1 shows that by the end of the study period, water demand will reach approximately the existing source capacity.

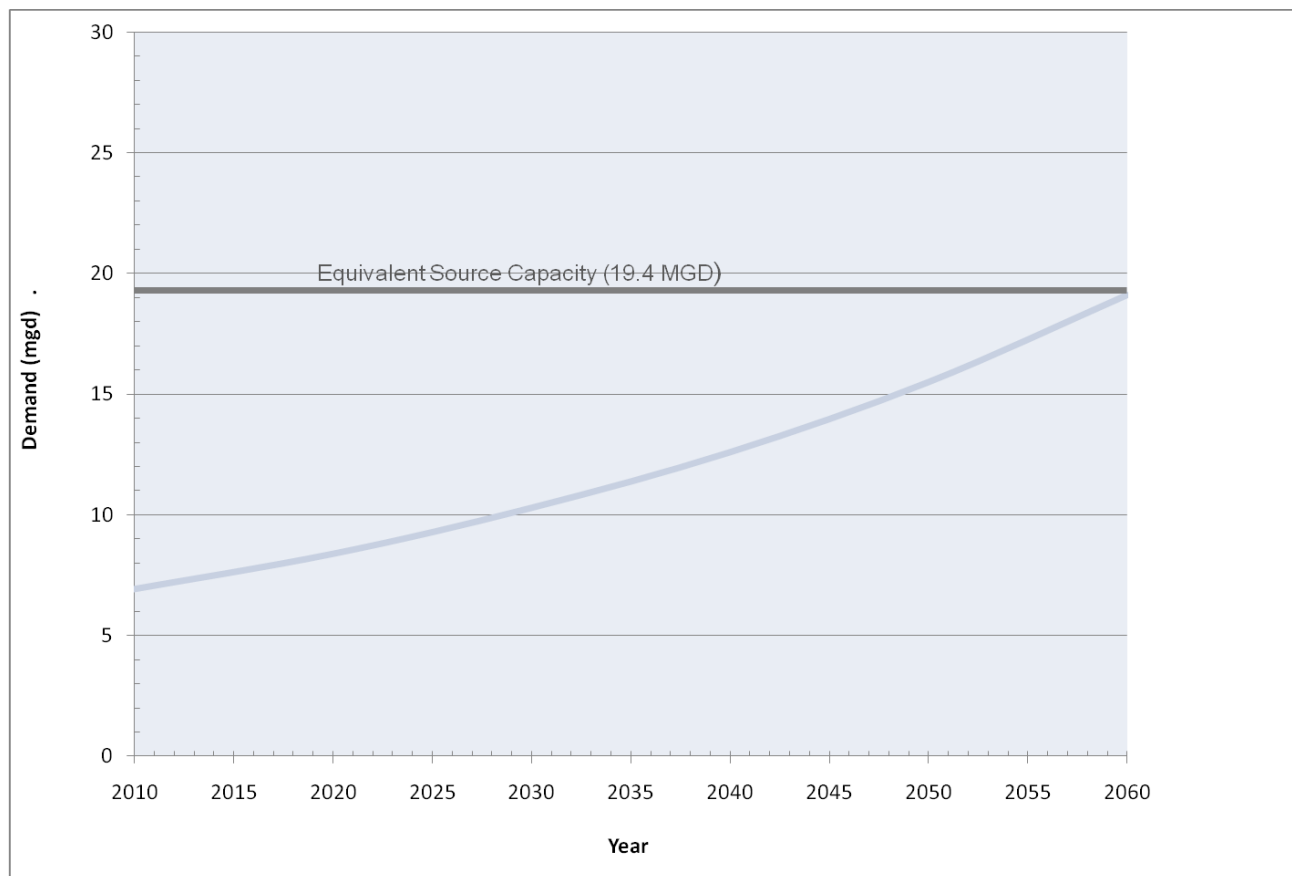


Figure 8-1: Source Capacity Adequacy Plot (average day demand projections)

8.1 Statement of Need

The Local and Regional Water Supply Planning (9 VAC 25-780-10 through 9 VAC 25-780-190) regulations state that a “clear statement of need shall contain, at a minimum, a determination of whether the existing source(s) is adequate to meet current and projected demands.”

Based on this analysis, the existing sources for the county will be adequate to meet the projected average day demands.

8.2 Alternative Analysis

The Local and Regional Water Supply Planning (9 VAC 25-780-10 through 9 VAC 25-780-190) regulations state that an alternative analysis of potential sources must include the following information:

1. A description of potential water savings from water demand management actions including an estimated volume for each action;
2. A description of potential sources for new supplies including an estimated volume from each source; and
3. A description of potential resource issues or impacts identified in accordance with 9 VAC 25-780-140 G, known for each potential new source that any future water project will need to consider in its development.

The regulations also state:

“Potential alternatives considered shall include water demand management alternatives as well as more traditional means of increasing supply, i.e., wells, reservoirs, impoundments and stream intakes. Where appropriate, the program shall consider nontraditional means of increasing supplies such as interconnection, desalination, recycling and reuse. The analysis of potential alternatives may include a combination of short-term and long-term alternatives.”

The alternative analysis process involved developing a comprehensive list of alternatives previously considered in earlier reports and studies for the region, and reviewing other opportunities. In order to evaluate these alternatives a screening workshop and a secondary evaluation was conducted to develop a portfolio of long-term water supply options. This process is shown in the Figure 8-2.



Figure 8-2: Alternative Analysis Process

8.3 Conceptual Development of Alternatives

Long-range water supply alternatives were developed first by reviewing alternatives explored in previous studies. The following previous studies (listed in chronological order) were used:

- Hayes, Seay, Mattern & Mattern, Inc. Water Supply Requirements - Evaluation of York River Basin Water Supply Alternatives. 1988.
- Hayes, Seay, Mattern & Mattern, Inc. Water Supply Requirements - Evaluation of Rappahannock River Basin Water Supply Alternatives. 1988.
- Hayes, Seay, Mattern & Mattern, Inc. Po River Reservoir - DRAFT Report - Environmental Impact Report. 1989.
- Hayes, Seay, Mattern & Mattern, Inc. Po River Reservoir - Appendix - Environmental Impact Report. 1989.
- Hayes, Seay, Mattern & Mattern, Inc. Po River Reservoir - Response to Comments - Environmental Impact Report. 1989.
- Hayes, Seay, Mattern & Mattern, Inc. Water Supply System - Final Environmental Impact Report. 1994.
- Hayes, Seay, Mattern & Mattern, Inc. Water Supply System - Appendix Final Environmental Impact Report. 1994.
- Hayes, Seay, Mattern & Mattern, Inc. Water Supply System - Addendum Environmental Impact Report. 1994.
- Whitman, Requardt and Associates Engineers. Fredericksburg - Water Supply and Treatment Alternatives TM No. 1 - Water Demand Projections (Revised). 1994.

- Whitman, Requardt and Associates Engineers. Fredericksburg - Water Supply and Treatment Alternatives TM No. 4 - Embrey Dam Evaluations. 1994.
- Whitman, Requardt and Associates Engineers. Fredericksburg - Water Supply and Treatment Alternatives TM No. 2 - River Flows (Revised). 1994.
- Hayes, Seay, Mattern & Mattern, Inc. Riverine Component. 1999.
- Black & Veatch, Inc. Orange County Water Supply Plan. 2006.

Additional alternatives were added based on a watershed level review of water resources with Spotsylvania County and City of Fredericksburg. Watersheds in Spotsylvania County are shown in Figure 8-3.

The alternatives were grouped into the following categories:

- A. Off-Stream Reservoirs
- B. On Stream Reservoirs
- C. Run of the River Intake
- D. Augmentation or Modification of Existing Sources
- E. Quarry Storage
- F. Groundwater
- G. Purchase Water / Interconnections
- H. Miscellaneous

A short description of each preliminary alternative is presented in the following sections. In addition, an overall map showing the location of the alternatives, Figure 8-5, is located at the end of the section.

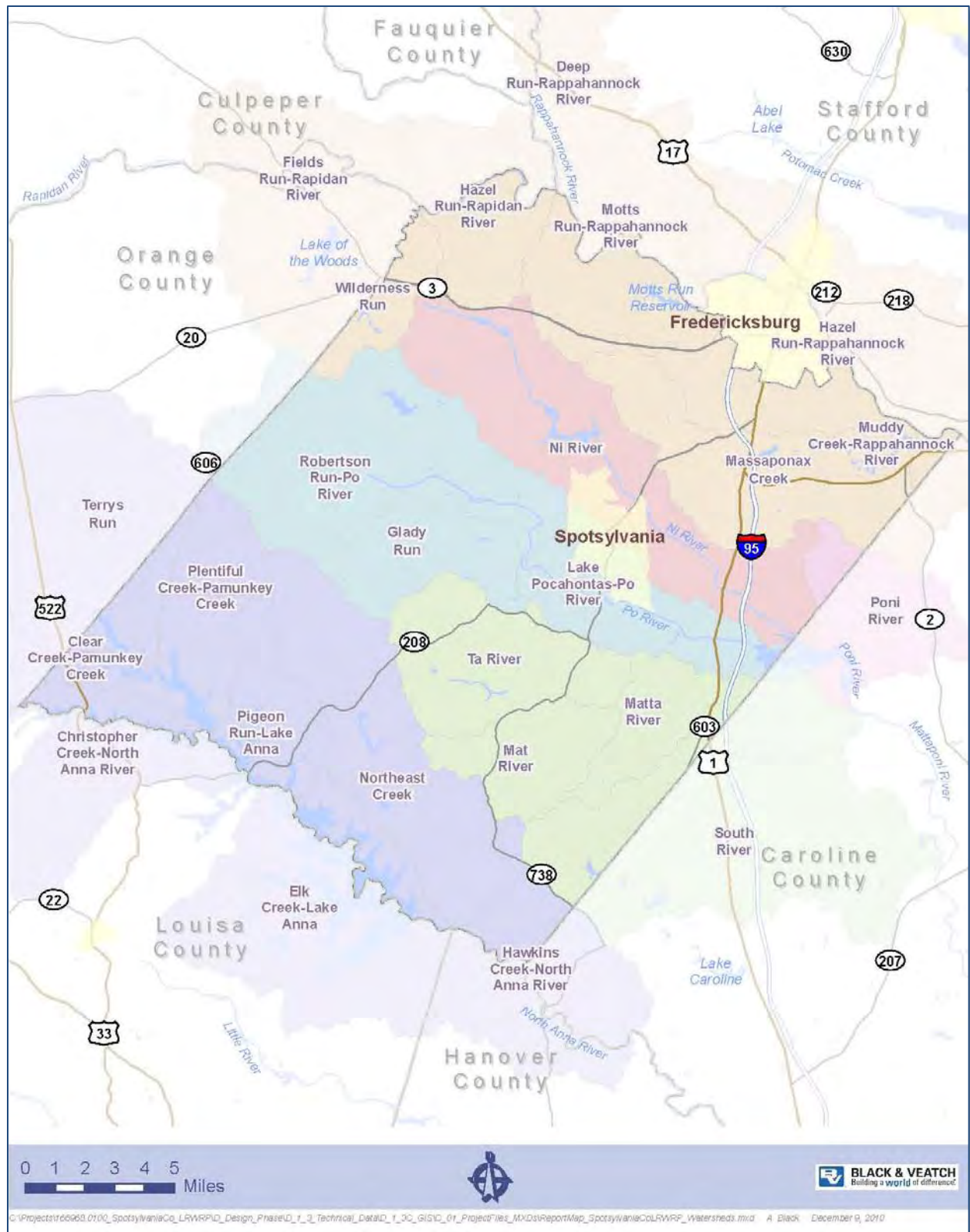


Figure 8-3: Spotsylvania County Watersheds

8.3.1 (A) Off-Stream Reservoirs

This category of alternatives refers to a type of reservoir that is not located in a streambed or does not receive significant natural flows from the surrounding watershed. Water from a nearby stream or river is withdrawn during periods of higher flow to augment the water stored in the reservoir. This allows water from the main stem of the river to be stored during periods of high flow. Typically, a site for an off-stream reservoir will have fewer adverse environmental impacts to wetlands as compared with an on-stream reservoir.

Alternative A1: New Pumped Storage Reservoir on Pipe Run Dam Run / Roque Run

Pipe Run Dam Run and Roque Run are tributaries to the Rappahannock River located southeast of the Hunting Run reservoir. This alternative has not been explored in previous studies. While there is a drainage area of 2.9 miles, most of the yield potential of the reservoir would be from pumping and storing water from the Rappahannock River.

This reservoir could impact some existing houses based on water surface elevation of 300 feet. The potential yield could be similar to Hunting Run reservoir, possibly in the range of 8 mgd, depending on the size of the reservoir and pump capacities.

No EPA Toxic Release Inventory (TRI) sites or Virginia Pollutant Discharge and Elimination System (VPDES) sites exist within the watershed.

Alternative A2: Utilization of Ruffin's Pond as a Pumped Storage Reservoir

This alternative is one of the few locations along the lower Rappahannock that may be able to serve as an off-stream reservoir. This site is located on Massaponax Creek in the far eastern corner of the County. This alternative has not been previously studied.

The drainage area is large for an off-stream reservoir, 38.4 square miles.

There are several WWTP's upstream on the Rappahannock River. Culpeper Woods Preserve is located on Ruffin's Pond. Several structures are located directly adjacent to the pond, so there would be limited or no area for an expansion. Additional water storage opportunities are limited.

LA Clarke & Son is an EPA Superfund site that is located within a mile upstream of this alternative.

Alternative A3: Conversion of Fawn Lake to a Pumped Storage Reservoir

This alternative involves converting the existing Fawn Lake to a water supply reservoir. Fawn lake is a 200 acre lake located on Greenfield Creek south of Wilderness Battlefield Military Park and has drainage area of 3.7 square miles. There is development surrounding the entire lake. This alternative was investigated as a part of permitting for a potential reservoir on the Po River. The yield was estimated to be 1.4 mgd as a standalone project or 3.8 mgd if the project augmented flow from the Po River.

This project was not recommended for further consideration during the Po River permitting effort in 1994 due to "costs, legal constraints, and environmental constraints (the inability of the County to protect the water quality and regulate land uses in and around a water body where large-scale development is occurring)."

Alternative A4: New Pumped Storage Reservoir in Mattaponi River Watershed in Caroline County

This alternative is located in Mattaponi River Watershed in Caroline County and has not been previously investigated. The reservoir could be located either on a tributary to (Campbell Creek for example) or on the main stem of the Mattaponi River. The drainage area for the entire watershed is 230 square miles.

The Bowling Green WWTP is located on a tributary near the center of the watershed. Hoover Treated Wood Products (VPDES site) is located toward the southern end of the watershed. The area is very rural with significant amounts of wetlands.

Alternative A5: New Pumped Storage Reservoir in the South River Watershed in Caroline County

This off-stream reservoir project would be located on the South River in northwestern Caroline County with pumping from the Mattaponi River. The total drainage area of the South River watershed is 63 square miles.

There are significant amounts of wetlands in and around this watershed. The area is very rural. VPDES or TRI sites in the watershed include: Dominion's Ladysmith Combustion Turbine Station, a mobile home park, and one additional land or utility site.

Alternative A6: New Pumped Storage Reservoir on Mountain Run in Orange County

This 234 acre reservoir project would be located on a tributary to the Rapidan River in northern Orange County. This alternative was previously investigated as part of the Orange County Regional Water Supply Plan. With an estimated storage volume of 1720 MG, and a raw water pump capacity of 15 mgd, the estimated yield is 4.0 mgd.

VPDES or TRI sites in the watershed include: Transcontinental Gas Pipeline – Station 180, and Aerojet Corporation. There appear to be significant wetlands in the watershed.

Alternative A7: New Pumped Storage Reservoir on Mine Run in Orange County

This 273 acre off-stream reservoir project would be located on a tributary to the Rapidan River in northern Orange County. This alternative was also previously investigated as part of the Orange County Regional Water Supply Plan. This alternative has an estimated storage volume of 1450 MG, with a raw water pumping capacity of 15 mgd. The estimated yield is 2.5 mgd.

There appear to be significant wetlands in this rural watershed. VPDES or TRI sites in the watershed include: Colonial Pipeline – Locust Grove and Locust Grove Elementary School.

Alternative A8: New Pumped Storage Reservoir on Poplar Laurel Run in Orange County

This 199 acre reservoir project would be located on a Poplar Laurel Run, a tributary to the Rapidan River in western Orange County. This alternative was also previously investigated as part of the Orange County Regional Water Supply Plan. This alternative has an estimated storage volume of 1720 MG; and with a pumping rate of 15 mgd, has an estimated yield of 4.0 mgd.

VPDES or TRI sites in the Poplar-Laurel watershed include: Town of Orange Sewage.

8.3.2 (B) On-Stream Reservoirs

On-stream reservoirs refer to a reservoir that is located in a main stem of a river and receives significant natural flows from the surrounding watershed. Traditionally these type of reservoirs have greater adverse environmental impacts than an off-stream reservoir. These impacts include wetlands, streams, endangered species and cultural resources.

Alternative B1: New Reservoir on the Po River, Upstream of Route 208

This alternative was previously in the process of being permitted and was considered the preferred alternative in 1994. This 600 acre reservoir was to be located upstream of Route 208 and had a drainage area of 77 square miles. The reservoir had a calculated yield of 7.7 mgd.

However, this alternative was estimated to impact over 136 acres of wetlands. This alternative also involved flooding of an archaeological site of possible historic/cultural significance (Long's Mill) and the encroachment of 100-yr floodplain (220-ft elevation) onto 3.2 acres of the Fredericksburg-Spotsylvania National Park. For these reasons and the permitting issues they presented, the alternative was abandoned.

There are a few houses that may be inundated. There are no TRI or VPDES sites in the watershed.

Alternative B2: New Reservoir on the Po River, Upstream of Route 648

This alternative was also previously considered during the attempt to permit the Po River Reservoir. The location of this reservoir was to be upstream of Route 648 on the Po River. This location was not considered further because it would flood 14.4 acres of the Fredericksburg-Spotsylvania National Military Park and would impact nearly 312 acres of wetlands.

There are a few houses that may have been inundated. No TRI or VPDES sites are in the watershed.

Alternative B3: New Reservoir on Wash Branch

This alternative is located on the Wash Branch tributary to the Ni River, south of the Chancellorsville Battlefield of the Fredericksburg-Spotsylvania National Military Parks. This alternative was considered during the Po River Reservoir permitting; however, it was abandoned during the process due to a low yield of 0.026 mgd.

There is a housing development on the branch that would likely be inundated. No TRI or VPDES sites are in the watershed.

Alternative B4: New Reservoir on Northeast Creek

This alternative would be located in the southern part of the county near Lake Anna on the Northeast Creek which flows into the Anna River just downstream of Lake Anna. The watershed has a drainage area of 42.2 square miles. This alternative has not been previously investigated.

There appears to be moderate to significant amount of wetlands in the watershed area. Most of the watershed is relatively rural. No TRI or VPDES sites are in the watershed.

Alternative B5: New Reservoir on Gladdy Run

This alternative is located in the central part of the county on Gladdy Run, which flows into the Po River. The watershed has a drainage area of 16.8 square miles. This alternative has not been previously investigated.

There appears to be moderate to significant amount of wetlands in the watershed area. Most of the watershed is relatively rural. No TRI or VPDES sites are in the watershed.

Alternative B6: New Reservoir on the Ta River

This alternative is located in the central part of the county on the Ta River, which joins the Mat River to form the Matta River. The watershed has a drainage area of 27.2 square miles. This alternative has not been previously investigated.

There is a significant amount of wetlands in the watershed. Most of the watershed is relatively rural, but there are several housing developments. An active sanitary landfill is located in the watershed, along with Spotsylvania County High School and the Beacon Hill Wastewater Treatment Plant.

Alternative B7: New Reservoir on the Mat River

This alternative is located in the central part of the county on the Mat River Watershed which joins the Ta River to form the Matta River. The watershed has a drainage area of 15.7 square miles. This alternative has not been previously investigated.

There is a significant amount of wetlands in the watershed area. Most of the watershed is relatively rural, but there are several housing developments. Berkley Elementary School is located within the watershed.

Alternative B8: New Reservoir on the Matta River

This alternative is located near the eastern border of the county on the Matta River. This alternative has not been previously investigated.

In order for the project to be upstream of the fall line, it would need to be west of Route 603. The project site (if near the fall line) has a drainage area of more than 43 square miles.

There are moderate to significant amounts of wetlands in the watershed area. There are quite a number of homes and housing developments in the area. TRI and VPDES sites upstream of the project include all of those listed for the Ta and Mat Rivers along with the Berkley Landfill, which is a closed landfill.

8.3.3 (C) Run of the River Intake

This alternative involves construction of water intake pumps on a stream or river large enough to provide the volume of water needed. Impacts to instream flow from pumping during times of drought can have a negative impact on the aquatic resources in a river.

Alternative C1: New Intake on the Lower Rappahannock River

This alternative was previously studied in the 1994 Water Supply System – Final Environmental Impact Report (HSMM). The project was determined as infeasible due to water quality concerns (considered "freshwater tidal" and sewage in industrial discharges upstream and downstream of the intake).

For this evaluation, the “Lower Rappahannock River” was assumed to be downstream of the fall line, but inside Spotsylvania County. The river waters actually fall outside of the Spotsylvania County boundary and are owned by Stafford County, which may pose some permitting challenges.

Several TRI and VPDES sites occur on the section of the River including three wastewater treatment facilities.

Alternative C2: New Intake on the Upper Rappahannock River

This alternative was previously studied in the 1994 Water Supply System – Final Environmental Impact Report (HSMM). The project was determined as infeasible due to low yield and reliability.

For this evaluation, the “Upper Rappahannock River” was assumed to be upstream of the fall line, and along the county boundary. The river waters actually fall outside of the Spotsylvania County boundary and are owned by Stafford County, which may pose some permitting challenges.

This project could be considered as a new intake facility or an addition to the existing intake for Motts Run.

Alternative C3: New Intake on the Po River

This alternative has not previously been evaluated as a self-standing option.

Since an intake on the Po River would likely not provide enough dependable yield to meet the county’s deficit during periods of drought, this alternative was combined with alternative D5.

Alternative C4: New Intake on Lake Anna

This alternative was previously studied in the 1989 Po River Reservoir – DRAFT Report – Environmental Impact Report (HSMM) and again in the 1994 Water Supply System – Final Environmental Impact Report (HSMM). Based on the 1994 report, the alternative was determined as infeasible “*due to incompatibilities regarding drastically different water use needs and associated legal constraint, the federal regulatory agencies have agreed that withdrawal from Lake Anna no longer constitutes a feasible alternative.*”

While permitting this withdrawal would be difficult due existing use of Lake Anna as a cooling reservoir for Dominion Virginia Power’s North Anna Nuclear Power Station, a intake would likely provide sufficient quantity of raw water. Dominion announced on Nov. 28, 2007, that it has filed an application with the U.S. Nuclear Regulatory Commission for a license to build and

operate a new nuclear reactor at its North Anna Power Station in central Virginia which could further complicate permitting.¹

8.3.4 (D) Augmentation or Modification of Existing Sources

Alternative D1: Expansion of Motts Run Reservoir

This alternative was previously studied in the 1994 Water Supply System – Final Environmental Impact Report (HSMM). According to this study, the alternative was "*determined to be infeasible in light of other available alternatives due to the relatively greater wetland impacts, continuing uncertainties relating to dam reconstruction and load bearing capacity under proposed conditions, and the presence of other feasible alternatives which would avoid impacts to public recreational lands.*"

The previous study indicated that raising the dam 15 feet would increase the yield from 3.4 mgd to 6.1 mgd, resulting in only a 2.4 mgd increase. There were also concerns about a loss of 7.43 acres of vegetated wetlands due to reservoir draining during construction and an additional 10.47 acres of vegetated wetlands from raising normal pool and inundation of 90.03 acres of upland terrestrial habitat. There was also a concern about the condition of the dam and what material comprised its core. Without this knowledge, the study concluded it was not possible to determine whether the dam would be capable of bearing additional loads associated with a larger volume of impounded waters.

Alternative D2: Expansion of Ni River Reservoir

This alternative would involve raising the normal pool elevation of the Ni River Reservoir. This alternative was previously studied in the 1994 Water Supply System – Final Environmental Impact Report (HSMM). The report indicated that raising dam 20 feet produces a yield ranging from 4 mgd to 9 mgd. A 9 foot raise (by modifying existing dam structure) would produce a yield ranging from 4.0 mgd to 5.6 mgd.

The alternative was previously determined to be “financially and technically infeasible because the reservoir would lose its ability to attenuate peak flows downstream of the dam and would result in a higher probability that private properties would be flooded.” In addition the study

¹ [North Anna Power Station Webpage](http://www.dom.com) (<http://www.dom.com>)

estimated that 5.1 acres to the Fredericksburg-Spotsylvania National Military Park would be flooded.

Alternative D3: Dredging of Ni River Reservoir

This alternative involves dredging the Ni River Reservoir. This alternative was previously studied in the 1994 Water Supply System – Final Environmental Impact Report (HSMM). The report stated the yield of reservoir would increase the yield by 0.7 mgd, 1.2 mgd, and 1.5 mgd for one, two, and three foot increments, respectively.

The report also noted that

"weighing the relatively small increase in water supply which would result from this alternative against 1) the county's projected needs, 2) the commitment of upland resources for dredge disposal, 3) impacts to water quality, and 4) impacts to existing wetland and aquatic ecosystems, dredging of the Ni River reservoir has been determined to be infeasible in light of other available alternatives."

Alternative D4: Augmentation of Ni River Reservoir with Rappahannock River

This alternative was previously studied in the 1994 Water Supply System – Final Environmental Impact Report (HSMM). The report combined raising the Ni River Reservoir by 9 feet and pumping from the Rappahannock River. The new yield for the elevated reservoir and pump-over was estimated as 6.2 mgd (an increase of 2.2 mgd).

Alternative D5: Augmentation of Ni River Reservoir with Po River

This alternative was previously studied in the 1994 Water Supply System – Final Environmental Impact Report (HSMM). The report combined raising the Ni River Reservoir by 9 feet and pumping from the Po River. The report assumed that no significant yield increase would occur with pumping from the Po River due to the river's small watershed. Additionally, *"a 'drought busting' storm occurring in the upper Po River basin would most likely occur in the Ni River Reservoir watershed and fill the reservoir, diminishing the utility of the Po River pump station."* Additionally, there were concerns associated with the projected 89 acres of wetlands impacts per 1.0 mgd increase in safe yield.

8.3.5 (E) Quarry Storage

These alternatives use retired quarries to store raw water, effectively using them as reservoirs.

Alternative E1: Utilization of Fall Quarry for Raw Water Storage

This alternative consists of storing raw water pumped from the Rappahannock River in the Fall Quarry, which is located within the City of Fredericksburg. Based on a conversation with a local dive shop who said the quarry depth was 40 feet, the quarry was determined to be too small to be utilized effectively for raw water storage and was deleted from further consideration¹. An aerial view of the quarry² is shown in Figure 8-4.



Figure 8-4: Falls Quarry near I-95 and City of Fredericksburg

Alternative E2: Utilization Luck Stone's Quarries for Raw Water Storage

This alternative involves storing raw water in two separate quarries located in eastern Spotsylvania County, while pumping from the Ni or Po River to fill the quarries. This alternative has not been previously studied.

¹ "Ralph Clark, Owner of Scuba Shop." Telephone interview. 11 Nov. 2010.

² "Bing Maps." *Bing*. 12 Dec. 2010. Web. 20 Dec. 2010. <<http://www.bing.com/maps>>

Luck Stone currently owns two quarries in Spotsylvania County, both adjacent to the Ni River downstream of the Ni River Reservoir. The “Spotsylvania Quarry” is located on the left bank (looking downstream) of the Ni River. The “Massaponax Quarry” is located approximately 4 miles downstream on the Right bank of the Ni River. This Massaponax Quarry site actually consists of two smaller adjacent quarries, but due to their close proximity, will be considered as one.

After mining is complete, there will be a potential to store up to 7.5 billion gallons (BG) in the Spotsylvania Quarry and 4 BG in the Massaponax Quarry. However, the quarries will not be available for at least 50 years.

The terms of Luck Stone’s permit require that they offer the sites to the County once they are done mining. Based on initial estimates, it is very likely that these quarries will be able to meet Spotsylvania’s supply gap.

8.3.6 (F) Groundwater

Alternative F1: Utilization of Groundwater Wells within the County

This alternative involves using groundwater wells to within the county. Spotsylvania County lies at the western limits of the Coastal Plain Physiographic Province, with most of the county within the Piedmont Physiographic Province. Generally, Piedmont aquifers are low yielding while Coastal Plain aquifers are highly variable in thickness and hydrologic characteristics.

This alternative was previously studied in the 1994 Water Supply System – Final Environmental Impact Report (HSMM), but was deleted due to low yield potential. This study noted that a third of the county residents (up to 15,000 people) were supplied with groundwater at the time of the study, and that the most high yielding and widespread source of groundwater is the Cretaceous-age Patuxent Formation.

The 1994 HSMM reports sites a groundwater study conducted by CH2M Hill. This CH2M Hill study concluded that "because of the limited lateral extent of Coastal Plain deposits (particularly the Cretaceous Patuxent Formation), the high degree of vertical and horizontal heterogeneity within the Coastal Plain aquifers, the presence of no-flow boundaries due to bedrock highs and the relatively low transmissivity of that aquifer with the highest potential yield (i.e., the Patuxent

formation), groundwater resources within Spotsylvania County are inadequate to meet the needs of a large-scale public water supply."

8.3.7 (G) Purchase Water / Interconnections

The following alternatives that involve purchasing additional water from another entity were included:

- Alternative G1: Purchase Water from the City of Fredericksburg
- Alternative G2: Purchase Water from Stafford County. There are two interconnections that can provide at least 2 mgd. Currently, the County is studying the feasibility of a larger interconnection.
- Alternative G3: Purchase Water from Orange County
- Alternative G4: Purchase Water from Caroline County
- Alternative G5: Purchase Water from Louisa County
- Alternative G6: Purchase Water from Culpeper County
- Alternative G7: Purchase Water from Hanover County. Hanover County has expressed interest in a future interconnection with Spotsylvania County. This interconnection may require distribution improvements.

8.3.8 (H) Miscellaneous

Alternative H1: Water Conservation Measures

This alternative involves Spotsylvania County adopting water conservation measures to reduce both indoor and outdoor water demand. A suite of water conservation measures were evaluated as a part of Task order 15 – Water Conservation Program in August of 2010.

Alternative H2: Aquifer Storage and Recovery (ASR)

This alternative was previously studied in the 1994 Water Supply System – Final Environmental Impact Report (HSMM). The report stated that aquifers in Spotsylvania County are low yielding, are highly variable in hydrologic characteristics, and are of limited extent due to bedrock highs. The project was deleted because the sites within the County do not meet the physical criteria for ASR as outlined by Pyne and Garcia-Bengochea, 1988. Sites within the county fall within the

acceptable range for leakage and total dissolved solids, but do not fall within the acceptable range for transmissivity.

Alternative H3: Water Reuse

This alternative involves the use of reclaimed water to reduce demand on a potable water system and/or provide a new water resource. Possible reuse opportunities generally can be separated into several main categories: irrigation; fire protection; industrial applications; construction; environmental uses; and miscellaneous uses. At this time, no survey of the Spotsylvania County has been undertaken.

There were three potential scenarios of water reuse considered in this alternative. One scenario involves selling wastewater effluent to Virginia Power, and using this wastewater to offset withdrawing raw water from Lake Anna. Another scenario could be constructing a scalping plant in the Fawn Lake area of Spotsylvania County and construct a purple pipe network and sell treated wastewater for local irrigation.

Both of these alternatives would involve constructing a smaller, satellite wastewater treatment facility in an area adjacent to demand. Satellite facilities are generally self-contained packaged units that require little operator attention. They have a small footprint and can be easily enclosed, making them ideal for areas where land availability is minimal and land cost and public exposure to the plant are high. Satellite treatment facilities can be hidden through maximizing use of subsurface structures, as well as blending with the local architecture through enclosure of the facilities and architectural treatment of the exterior. A satellite treatment facility can be a cost-effective solution for small reuse plants located within highly visible areas including parks and residential neighborhoods

Satellite water reclamation facilities receive wastewater from the main collection system and treat this side stream to reuse water standards. The satellite facilities then return solids from the treatment process back to the sewer collection system for transport to the main treatment plant(s) for processing and treatment. Recent advances in wastewater treatment technology make satellite treatment facilities economically and environmentally acceptable.

The typical advanced tertiary treatment processes selected for satellite facilities is the membrane bio-reactor (MBR). The MBR process consists of a suspended growth biological reactor with

membranes for solids separation. The membranes are submerged in the aeration tank in direct contact with the mixed liquor. A vacuum pump draws the product water through the membranes. The membranes provide a very high quality effluent. The membranes remove all bacteria and provide effluent turbidities of 0.1 NTU. The positive mechanism for solids separation also results in a very easy process to operate because there are no conventional clarifiers subject to settling upsets.

A final scenario could be to augment Rappahannock River with effluent from Massaponax WWTP by pumping effluent upstream to a location just downstream of the existing intake on the Rappahannock River. An increased capacity of Rappahannock raw water intake may be realized.

Alternative H4: Upper Caroline / Lower Spotsylvania County Desalination Plant with Lower Rappahannock Intake

Because the great majority of high quality surface water supplies have already been allocated, the treatment and use of alternate lower quality water supplies is becoming more and more popular. With advancements in desalination and brine management technologies, the desalination of ocean or brackish waters is becoming more common.

This alternative assumes a feasible location would be near the town of Tappahannock on the lower Rappahannock River. Raw water Pipeline would need to be 50-miles (minimum) and would run through Caroline and Essex Counties. A second pipeline would be required to pump brine back to Tappahannock, which would be too saline to pump back into Rappahannock.

Desalination in general is an energy-intensive treatment process. Therefore, large desalination plants are often co-sited with power plants to increase their energy efficiency. Half of the operation and maintenance cost for Tampa Bay Water's desalination plant is related to energy costs.¹

Desalination was previously considered in the 1994 Water Supply System – Final Environmental Impact Report (HSMM), and determined as infeasible due to issues with the required location of the intake (outside of the county). However, desalination technology has dramatically improved due to more efficient membranes to reduce the energy use in desalination.

¹ Tampa Bay Water 2008 Project Concept Shortlist Evaluation. Black & Veatch

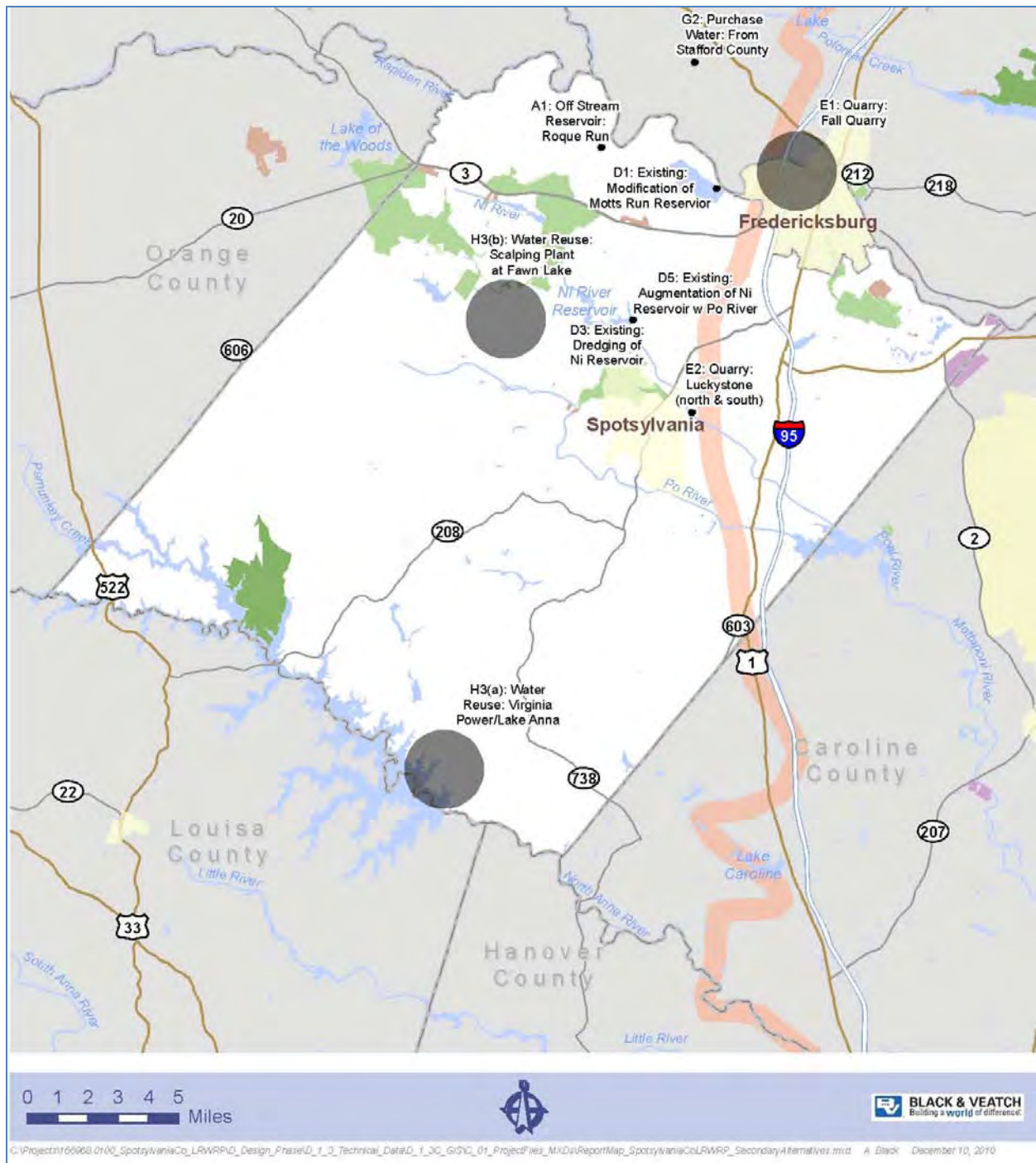


Figure 8-5: Map of Alternatives (Circles represent general area of alternative)

8.4 Preliminary Alternatives Evaluation

The comprehensive list of alternatives was evaluated as part of a workshop with the Utilities Department staff, held on April 16, 2010. The alternatives were reviewed prior to screening and the following alternatives were deleted due to either insufficient data or unrealistic potential:

- B2 – On Stream Reservoir: Po River Reservoir
- B3 – On Stream Reservoir: Wash Branch Reservoir
- B7 – On Stream Reservoir: Mat River
- E1 – Fall Quarry
- F1 – Groundwater Wells within County
- G1 – Purchase: Fredericksburg
- G3 – Purchase Orange County
- G4 – Purchase: Caroline County
- G5 – Louisa County
- G6 – Culpeper County
- H2 – MISC AS

A set of primary criteria was selected which included reliability/redundancy, environmental impacts, cost, and stakeholder benefits. Each of these criteria was weighted by the Utilities Department Staff (10 being high priority, 1 being low priority). Sub-Criteria were then developed for each of the primary criteria and subsequently weighted for alternative evaluation. Weightings were then chosen by the group to reflect the relative importance of each criterion. The results, criteria, and weighting of this group exercise are shown in Figure 8-6.

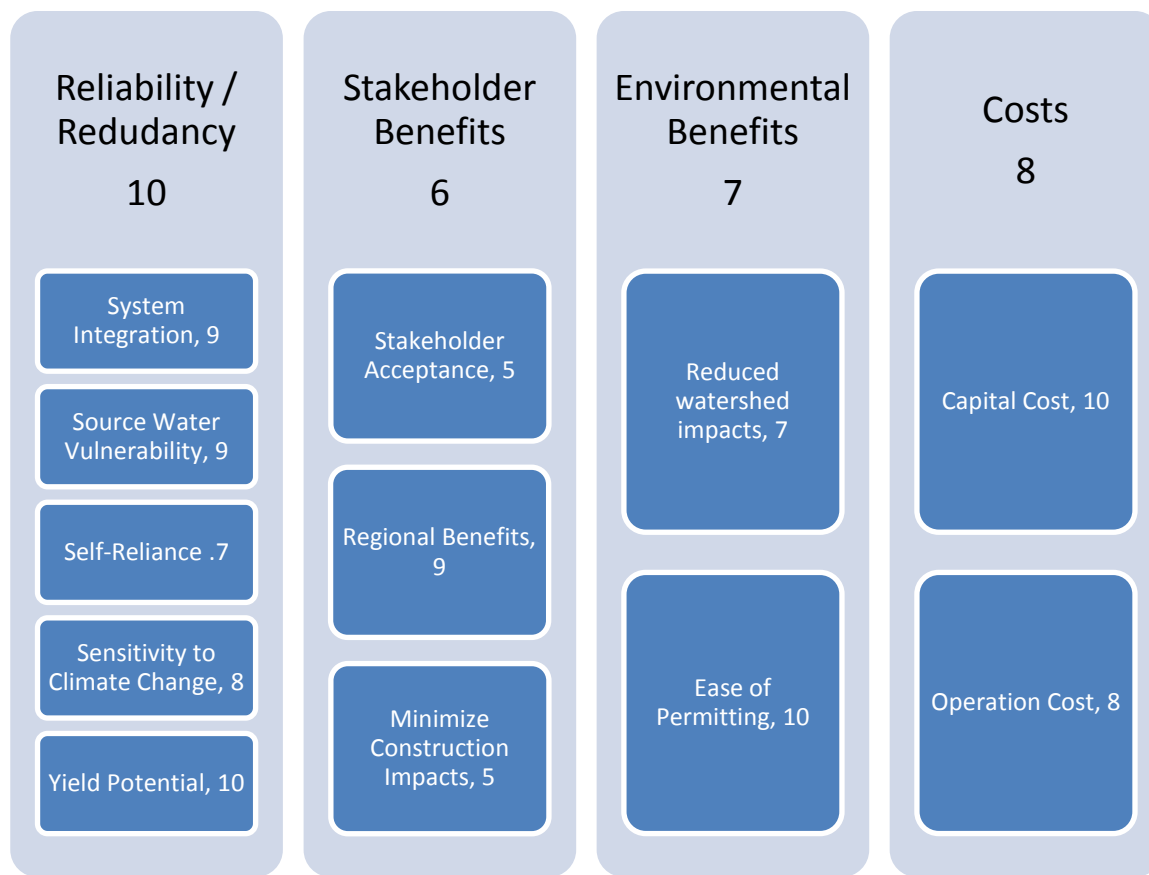


Figure 8-6: Preliminary Alternative Analysis Criteria and Weighting

Each preliminary alternative was scored by assigning a “+”, “0”, or “-” for each criterion. A “+” rating represented positive outcome while a “0” rating represented a neutral outcome and a “-” rating represented a negative outcome. A spreadsheet model was used to score each preliminary alternative. A value of 1 was assigned for “+”, a value of 0 for “0”, and a value of -1 for “-”. The score of each alternative was then calculated based on the assigned weightings.

8.5 Preliminary Alternatives Screening / Workshop Results

The scores and rankings of the preliminary alternatives are shown in Table 8-1 below. Note that Alternative E1 – Fall Quarry was not scored due to the lack of information available at the time of the workshop.

Table 8-1: Ranking of Preliminary Alternatives

Rank	Alternative	Score (x 100)
1	D3 EXISTING: Dredging of Ni Reservoir	62
2	D1 EXISTING: Expansion of Motts Run Reservoir	60
3	H1 MISC: Water Conservation Measures	56
4	E2 QUARRY: Luck Stone	55
5	H3 MISC: Water Reuse (Lake Anna, Fawn Lake, or Massaponax WWTP)	55
6	G2 PURCHASE: Stafford County	46
7	C2 INTAKE: Upper Rappahannock Intake	37
8	D5 EXISTING: Augmentation of Ni Reservoir with Po River (NOT RAISING)	19
9	A1 OFF STREAM RESERVOIR: Roque Run	11
10	D2 EXISTING: Ni River Reservoir Expansion	-1
11	G7 PURCHASE: Hanover County	-1
12	C1 INTAKE: Lower Rappahannock Intake	-5
13	A2 OFF STREAM RESERVOIR: Ruffin's Pond	-6
14	D4 EXISTING: Augmentation of Ni Reservoir w Rappahannock River (NOT RAISING)	-7
15	A8 OFF STREAM RESERVOIR: Poplar Laurel Run (Orange Co.)	-11
15	A7 OFF STREAM RESERVOIR: Mine Run (Orange Co.)	-11
15	A6 OFF STREAM RESERVOIR: Mountain Run (Orange Co.)	-11
18	A3 OFF STREAM RESERVOIR: Conversion of Fawn Lake	-15
19	B5 ON-STREAM RESERVOIR: Gladly Run	-21
19	B4 ON-STREAM RESERVOIR: Northeast Creek	-21
21	H4 MISC: Upper Caroline/Lower Spotsylvania Intake & Desalination Plant	-22
22	B1 ON-STREAM RESERVOIR: Po River Reservoir (u/s or Route 208)	-23
23	B8 ON-STREAM RESERVOIR: Matta River	-27
24	A4 OFF STREAM RESERVOIR: Campbell Creek - Mattaponi River Watershed (Caroline Co.)	-36
25	C4 INTAKE: Withdrawal from Lake Anna	-40
26	A5 OFF STREAM RESERVOIR: South River Watershed (Caroline Co.)	-50
27	B6 ON-STREAM RESERVOIR: Ta River	-51

Alternatives that received a positive score were retained for further evaluations. Some of the alternatives were modified and or combined based on discussions during the workshop. The workshop participants decided that the top 12 alternatives should be considered for further evaluation.

The selected alternatives by category are listed below.

8.5.1 A. Off-Stream Reservoirs

Alternative A1: New Pumped Storage Reservoir on Roque Run/Pipe Dam Run. This alternative was retained as previously defined.

8.5.2 C. Run of the River Intake

Alternative C1: New Intake on the Lower Rappahannock River. This alternative was retained as previously defined.

Alternative C2: New Intake on the Upper Rappahannock. This alternative was included as a part of Alternative H3(c) which is described below. This alternative was not retained as a stand-alone alternative.

8.5.3 D. Augmentation or Modification of Existing Sources

Alternative D1: Expansion of Motts Run Reservoir. This alternative was retained as previously defined. While this alternative was considered unfeasible in the 1994 Water Supply System – Final Environmental Impact Report (HSMM), the technical challenges of expanding a reservoir do not represent a fatal flaw in this alternative that would prevent further evaluation.

Alternative D2: Expansion of Ni River Reservoir. This alternative was retained as previously defined. This alternative was considered unfeasible in the 1994 Water Supply System – Final Environmental Impact Report (HSMM), because of concerns over associated impacts representing raising the dam 9 feet and 20 feet. While these impacts could present a challenge in the future, these challenges do not represent a fatal flaw in this alternative to prevent further evaluation.

Alternative D3: Dredging of the Ni River Reservoir. This alternative was retained as previously defined.

Alternative D5: Augmentation of Ni River with Po River. This alternative was retained as previously defined.

8.5.4 E. Quarry

Alternative E2: Utilizing Luck Stone's Quarries for Raw Water Storage. This alternative was retained as previously defined.

8.5.5 G. Purchase Water / Interconnections

Alternative G2: Purchase water from Stafford County. This alternative was retained as previously defined. In addition, a new variation of this alternative, G2a, was added which assumed a new larger interconnect between the counties.

Alternative G7: Purchase water from Hanover County. This alternative was retained as previously defined.

8.5.6 H. Miscellaneous

Alternative H1: Water Conservation Measures. This alternative includes utilizing water conservation measures to delay source capacity expansion. This approach differs from traditional water supply management, which aims at increasing the supply whatever the demand. Water demand management differs from water supply management in that it targets the water user rather than the supply of water to achieve more desirable allocations and sustainable use of water. Apart from structural measures such as drip irrigation or low-flow plumbing fixtures, demand management strategies mainly consist of non-structural measures such as economic and legal incentives to change the behavior of water users.

Alternative H3: Water Reuse. This alternative was retained with the following added variations:

- Alternative H3(a) – This scenario involves selling wastewater effluent to Virginia Power, and using this wastewater to offset withdrawing raw water from Lake Anna.

- Alternative H3(b) – This scenario involves constructing a small wastewater treatment plant in the Fawn Lake area and developing infrastructure to sell treated wastewater for local irrigation.
- Alternative H3(c) – This scenario involves augmenting the Rappahannock River with effluent from Massaponax WWTP by pumping effluent upstream to a location just downstream of the existing intake on the Rappahannock River.
- Alternative H3(d) – This scenario involves selling wastewater treated at the Massaponax WWTP to local industrial users within a couple mile radius.

8.6 Secondary Alternatives Evaluation

The goal of this evaluation was to further screen the secondary alternatives into a focused portfolio of potential projects that could help Spotsylvania County prioritize potential projects. This evaluation involved making estimates of high-level capital costs and additional yields for these secondary alternatives.

8.6.1 Cost and Yield Development

While a more detailed evaluation of capital cost was conducted for each secondary alternative, the results show a range of uncertainty. A precise assessment would have required detailed technical design and hydrology studies that were outside the scope of this study. However, the estimates are comparable across the set of secondary alternatives and are based upon the use of common estimation methodologies and standard input assumptions, where appropriate.

A standard construction markup of 35 percent was used to cover unforeseen expenses, mobilization/demobilization, and contractor's overhead and profit during a project. This includes the following:

- Contingencies – 20%
- Contractor's overhead and profit – 10%
- Mobilization/demobilization – 5%

In addition, a standard multiplier of 20 percent was added to the total construction cost which included 15% engineering and administration; and 5% for permitting. It is important to note that

water treatment costs were not included since they were considered comparable between the alternatives for this analysis. The capital cost and potential yield range is shown in Table 8-2.

Table 8-2: Capital Cost and Potential Yield Summary								
Alternative		Additional Yield Range (mgd)			Capital Cost Range (millions)			Average Cost per Average Yield
		Low	High	Avg.	Low	High	Avg.	
D3	Dredging of the Ni River Reservoir	2	3	2.2	\$22	\$66	\$44	\$20
D1	Expansion of Motts Run Reservoir	3	n/a	3	\$17	\$31	\$24	\$8
E2	Utilizing Luck Stone's Quarries for Raw Water Storage	1	4	2.6	\$37	\$45	\$41	\$15
H3(a)	Water Reuse – Virginia Power/Lake Anna	2	2	2	\$67	\$82	\$75	\$37
H3(b)	Water Reuse – Scalping Plant at Fawn Lake	.5	.5	.5	\$8	\$10	\$9	\$18
H3(c)	Water Reuse – Augmentation of Upper Rappahannock River with Massaponax WWTP effluent	2	2	2	\$18	\$22	\$20	\$10
H3(d)	Water Reuse – Sell Treated Wastewater from the Massaponax WWTP	.5	.5	.5	\$12	\$15	\$14	\$27
D5(a)	Augmentation of Ni River/Reservoir with Po River	.5	.5	.5	\$18	\$22	\$20	\$42
A1	New Pumped Storage Reservoir on Roque Run/Pipe Dam Run	1	1	1.3	\$37	\$45	\$41	\$32

Table 8-2: Capital Cost and Potential Yield Summary								
Alternative		Additional Yield Range (mgd)			Capital Cost Range (millions)			Average Cost per Average Yield
		Low	High	Avg.	Low	High	Avg.	
H1	Water Conservation Measures	1	1	1	\$1	\$1	\$1	\$1
D2	Expansion of Ni River Reservoir	4	6	5	\$15	\$26	\$21	\$4
C1	New Intake on the Lower Rappahannock River	5	5	5	\$31	\$46	\$39	\$8
C2	New Intake on the Upper Rappahannock River	5	5	5	\$10	\$20	\$15	\$3
G7	Purchase water from Hanover County	2	2	2	4	4	4	\$2
G2	Purchase water from Stafford County (Existing)	2	2	2	0	0	0	\$0
G2a	Purchase water from Stafford County(Larger Connection)	5	5	5	5	7	6	\$1

8.6.2 Portfolio Selection

The alternatives were then reviewed by comparing planning level capital cost per mgd for each alternative and the potential available yield. As shown on Figure 8-7, the comparison shows a wide range of cost and yield for each alternative. In addition, no category was shown to be exclusively the most cost effective. Alternatives highlighted in red were considered based on a lower potential cost per mgd.

This portfolio of preferential alternatives represents three general types of options: water conservation, capture/storage, and capture as shown in Table 8-3. The average yield for this group of alternatives is 3 mgd, with a \$21 million average capital cost.

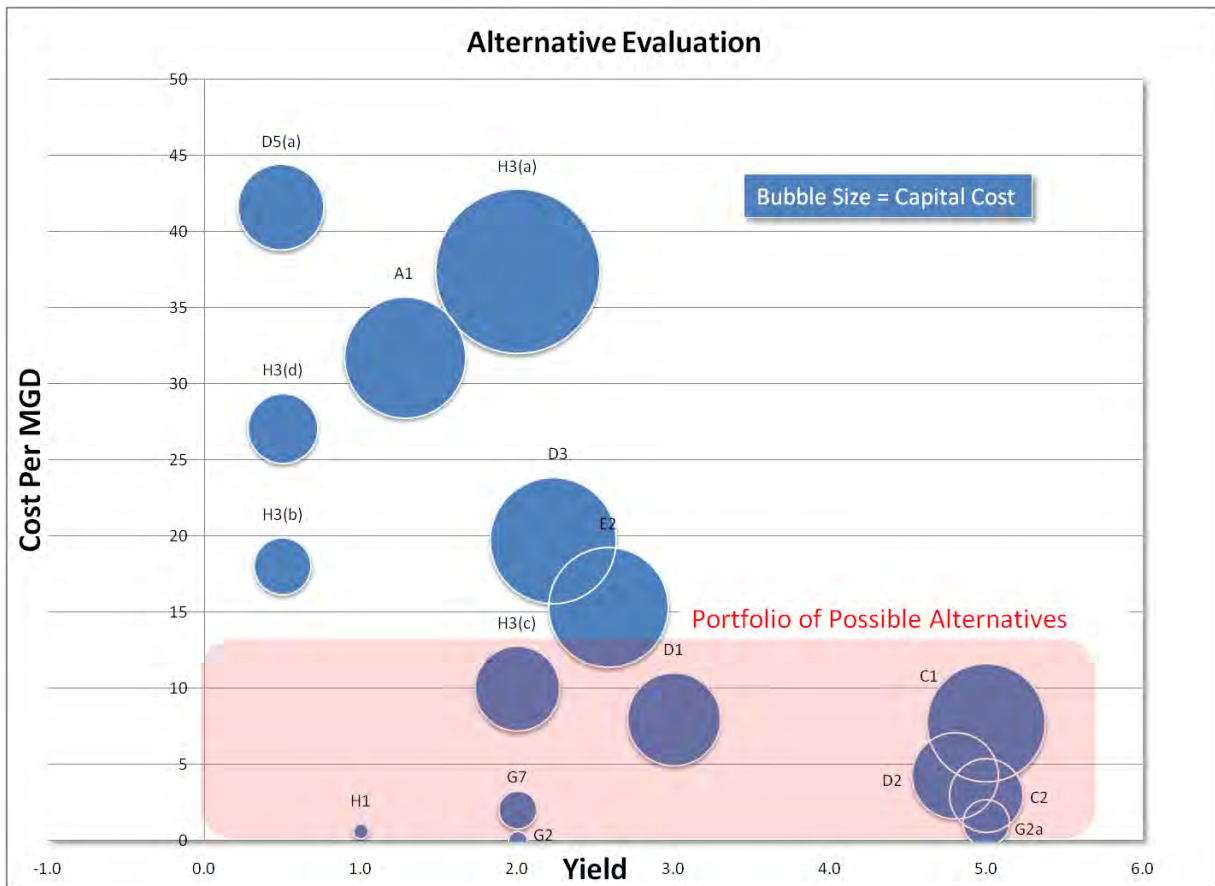


Figure 8-7: Secondary Alternatives Comparison

Table 8-3: Portfolio of Recommended Alternatives				
Alternatives		Overall Type	Average Yield (mgd)	Average Capital Cost (Million)
D1	Expansion of Motts Run Reservoir	Capture/Storage	3	\$24
H3(c)	Water Reuse – Augmentation of Upper Rappahannock River with Massaponax WWTP effluent	Water Conservation	2	\$20
H1	Water conservation measures	Water Conservation	1	\$1
E2	Utilizing Luck Stone’s Quarries for Raw Water Storage	Capture/Storage	2.6	\$41
G7	Purchase water from Hanover County	Transfer	2	4
G2	Purchase water from Stafford County (Existing)	Transfer	2	0
G2a	Purchase water from Stafford County (Larger Connection)	Transfer	5	6
D2	Expansion of Ni River Reservoir	Capture/Storage	5	\$21

C1	New Intake on the Lower Rappahannock River	Capture	5	\$39
Average			3	\$21

8.7 Alternative Analysis Conclusions

As a result of the adequacy evaluation, it was determined that the County has the source water capacity to meet the average demand projections through the year 2060.

Based on the alternative analysis, there are multiple viable options to address the source water capacity beyond 2060. Due to lack of immediate need for additional source water, the most cost-effective alternatives were included in a portfolio of preferential alternatives. These alternatives include:

- Expansion of Motts Run Reservoir
- Water Reuse – Augmentation of Upper Rappahannock River with Massaponax WWTP effluent
- Water Conservation Measures
- Expansion of Ni River Reservoir
- New Intake on the Lower Rappahannock River
- Purchase Water Alternatives from Stafford or Hanover

Future development of these alternatives can require significant pre-work with permitting, technical design and environmental impact studies, which could take up to ten years prior to start of construction. Since source water capacity currently is not needed beyond 2060, it is suggested that the County re-evaluate both these and the primary alternatives at regular planning intervals. This may be accomplished as a part of the ongoing Regional Water Supply Planning in accordance with the Virginia State Water Control Board "Local and Regional Water Supply Planning Regulations," VAC 25-780, which require plans to be updated every five years. Logistical, legal, and political considerations for these alternatives will evolve in the future and may determine which alternative, or multiple alternatives, are further studied or implemented.

However, considering the potential cost-effectiveness of the water conservation alternative, continued development of the County's Water Conservation Program may be a priority. Water conservation options require time to measure demand changes, as they rely on consumer adoption and behavioral changes. For example, options such as the use of more efficient water

fixtures would require consumers to adopt the option and/or change their behavior, which could take several years. As a water conservation program evolves, the County will need to measure results and continually determine the appropriate mix of incentives and/or mandates. For example, customers might be provided with financial incentives to replace their high flow toilets, or the County could mandate that all high flow toilets in the County be replaced.

The limitations of this alternative analysis should be clearly understood. Accordingly, the contents of this analysis should be taken as initial findings and recommendations that will provide a basis for further study and analysis. All yield and capital cost estimates are preliminary and are likely to change with further analysis.

This diverse portfolio of recommended alternatives ensures Spotsylvania County can focus on the most cost-effective options in the future and may provide potential contingency options available if available source water quantity changes or demand patterns change. These alternatives will allow Spotsylvania County to focus on a diverse set of project concepts that have sufficient water quantity to meet the future water needs in the planning duration.

Appendix A

CODE
County of SPOTSYLVANIA, VIRGINIA

Codified through
Ordinance No. 24-4, adopted June 8, 2010.
(Supplement No. 89, Update 1)

ARTICLE II. WATER SERVICE*

DIVISION 8. WATER EMERGENCIES

Sec. 22-201. Authority to declare water emergencies.

During the continued existence of climatic, hydrological and other extraordinary conditions the protection of the health, safety and welfare of the residents of the County of Spotsylvania may require that certain uses of water, not essential to public health, safety and welfare, be reduced, restricted or curtailed. As the shortage of potable water becomes increasingly more critical, conservation measures to reduce consumption or curtail essential water use may be necessary.

The county administrator, with the approval of the chairman of the board of supervisors, is authorized to declare water emergencies in the county affecting the use of water in any area of the county and to control and restrict the use of water during an emergency caused by a water shortage or other cause.

(Code 1980, § 17-48; Ord. No. 22-3, 9-24-91)

Sec. 22-202. Publication of declaration.

Upon the declaration of a water emergency pursuant to section 22-201, the county administrator shall post a written notice of the emergency as soon as practicable at the front door of the circuit court courthouse or at the designated public bulletin board and shall place a notice in a newspaper of general circulation in the area in which such emergency has been declared.

(Code 1980, § 17-49; Ord. No. 22-3, 9-24-91; Ord. No. 22-27, 11-13-07)

Sec. 22-203. Use of water restricted.

Upon the declaration of a water emergency pursuant to section 22-201, the county administrator is authorized and directed to implement conservation measures by ordering the restricted use or absolute curtailment of the use of water for certain nonessential purposes for the duration of the water shortage in the manner hereinafter set out. In exercising this discretionary authority, and making the determinations set forth in section 22-205 hereof, the county administrator shall give due consideration to water levels, available/usable storage on hand, draw down rates and the projected supply capability in source reservoirs in Spotsylvania County, and other localities supplying water to the county; supply capacity, rate of usage and projected supplies of wells in the water system and open stream sources available to the water system; system purification and pumping capacity; daily water consumption and consumption projections of the system's customers; prevailing and forecast weather conditions; fire service requirements; pipeline conditions including breakages, stoppages and leaks; supplementary source data; estimates of minimum essential supplies to preserve public health and safety and such other data pertinent to the past, current and projected water demands.

All data collected and considered by the county administrator shall be reduced to writing and maintained by the county administrator.

(Code 1980, § 17-50; Ord. No. 22-3, 9-24-91)

Sec. 22-204. Limitation of restrictions.

The provisions of this division, or regulations promulgated hereunder by the county administrator, which are hereby authorized, shall not apply to any governmental activity, institution, business or industry which shall be declared by the county administrator, upon a proper showing, to be necessary for the public health, safety and welfare or the prevention of severe economic hardship or the substantial loss of

employment. Any activity, institution, business or industry aggrieved by the finding of the county administrator may appeal that decision to the board of supervisors.

(Ord. No. 22-3, 9-24-91)

Sec. 22-205. Water conservation measures.

Upon a determination by the county administrator of the existence of the following conditions, the county administrator shall take the following actions which shall apply to any person whose water supply is furnished from the county water system:

(a) *Condition 1:* When moderate but limited supplies of water are available, the county administrator shall, through appropriate means, call upon the general population to employ prudent restraint in water usage, and to conserve water voluntarily by whatever methods available.

(b) *Condition 2:* When very limited supplies of water are available, the county administrator shall order curtailment of less essential usages of water, including, but not limited to, one (1) or more of the following:

(1) The watering of shrubbery, trees, lawns, grass, plants, or any other vegetation, except indoor plantings, greenhouse or nursery stocks and except limited watering for newly seeded lawns and watering by commercial nurseries of freshly planted plants upon planting and once a week for five (5) weeks following planting.

(2) The washing of automobiles, trucks, trailers, boats, airplanes, or any other type of mobile equipment, except in facilities operating with a water recycling system approved by the administrator; provided, however, that any facility operating with a water recycling system shall prominently display in public view a notice approved by the administrator stating that such recycling system is in operation. In lieu of the provisions hereof the county administrator may curtail the hours of operation of commercial enterprises offering such services or which wash their equipment.

(3) The washing of streets, driveways, parking lots, service stations aprons, office buildings, exteriors of homes or apartments, or other outdoor surfaces.

(4) The operation of any ornamental fountain or other structure making a similar use of water.

(5) The filling of swimming and/or wading pools, or the refilling of swimming and/or wading pools which were drained after the effective date of the order.

(6) The use of water from fire hydrants for any purpose other than fire suppression or other public emergency.

(7) The serving of drinking water in restaurants, cafeterias or any other food establishment unless requested by the individual.

(c) *Condition 3:* When critically limited supplies of water are available, the county administrator shall institute mandatory reductions on each customer as follows:

(1) Industrial, institutional, commercial, governmental, wholesale and all other nonresidential customers shall be allotted a percentage reduction based on that customer's average monthly and/or quarterly previous calendar year's consumption.

(2) Individual residential customers shall be limited to a specific volume or percentage reduction of water per quarter.

If the allotted monthly/or quarterly water usage is exceeded, the customer shall be charged as set forth in the following table) for every one thousand (1,000) gallons of water consumed above the allotted volume. Where prior consumption data is not available the county administrator shall estimate allocations based upon the data available from similar activities of equal intensity.

TABLE INSET:

Current until March 1, 2006	Monthly fees effective with the first bill after February 28, 2006; All others Effective March 1,	Monthly fees effective with the first bill after June 30, 2007; All others Effective July 1, 2007	Monthly fees effective with the first bill after June 30, 2008; All others Effective July 1, 2008
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	2006		
\$20.00	\$25.00	\$30.00	\$35.00

(d) *Condition 4:* When crucially limited supplies of water are available, the county administrator shall restrict the use of water to purposes which are absolutely essential to life, health and safety.

The determination of Conditions 2, 3 and 4 by the county administrator shall be accompanied by a written report which shall set out the criteria utilized and data relied upon in making such determination including a narrative summary supporting the determination. Each report shall be available for public inspection in the county administrator's office. The county administrator shall forthwith transmit a copy of each report to the board of supervisors.

(Ord. No. 22-3, 9-24-91; Ord. No. 22-20, 8-10-04; Ord. No. 22-23, 12-13-05)

Sec. 22-206. Penalty.

Any person who shall violate any of the provisions of this division, or of any of the conservation regulations promulgated by the county administrator pursuant thereto, shall, upon conviction thereof, in addition to additional charges set forth in subsection 22-205(c) be fined not less than one hundred dollars (\$100.00), nor more than two thousand five hundred dollars (\$2,500.00). Each act or each day's continuation of a violation shall be considered a separate offense. In addition to the foregoing, the county administrator may suspend water service to any person continuing to violate the provisions of this ordinance or the regulations promulgated thereunder. If such water service is terminated, the person shall pay a reconnection fee of fifty dollars (\$50.00) before service is restored.

(Ord. No. 22-3, 9-24-91)

Sec. 22-207. Notification of end of water emergency.

The county administrator shall notify the board of supervisors when, in his opinion, the water emergency situation no longer exists. Upon concurrence of the board, the water emergency shall be declared to have ended.

(Ord. No. 22-3, 9-24-91)

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